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NUTRITION SURVEYS: THEIR TECHNIQUES AND VALUE

By

Committee on Nutrition Surveys
Food and Nutrition Board
Division of Biology and Agriculture

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FOREWORD

The Committee on Nutrition Surveys, which is responsible for the publication of this volume, was set up by the Food and Nutrition Board in April 1944, when a request for information concerning the methods by which the nutritional well being of the public could be periodically tested was received from the so-called Truman (Senate Investigation) Committee.

On many occasions during the war the Board had emphasized the need for a regular system of dietary and nutritional surveys of representative samples of the population to determine how the people were faring in the face of food rationing, scarcities of some common foods, interruptions and delays in food transportation, rises and declines in income and the cost of living, and the marked changes in working and living conditions brought about by the war.

The Board believed that information on the current dietary and nutritional status of the people would make it possible to frame the most suitable food policies, and to appraise and adjust these policies to the actual conditions and needs of the different groups in the population.

When the war ended, the Board refused to discharge the Committee, insisting that its work was just as important in peace as in time of war.

The Committee agreed to continue its work and in May 1946 presented to the Board the plan of the present volume. Like all publications of the Board and its committees, this volume is dedicated to the health of the American people; its purpose is to make available to doctors, health officers, nutritionists and all others concerned the latest information concerning the methods and value of dietary and nutritional surveys. It is the hope of all those who have been concerned directly or indirectly with this publication, that advances in our knowledge of nutrition and more precise methods of appraising nutritional status may soon make it necessary to prepare a new edition.

The publication of this volume does not bring the Committee's work to an end. It is simply one step on the road to better methods of appraisal and greater use of those methods in the campaign for better health through improved nutrition.

The Board is most appreciative of the unremitting efforts of the Committee and most grateful to the members for their individual contributions.

FRANK G. BOUDREAU, M.D.
Chairman, Food and Nutrition Board

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PREFACE

The problem of establishing and maintaining good food habits within a community or nation is exceedingly complex. In the first place, food consumption practices are subject to both gradual and sudden changes as a result of varying economic, social, political, and environmental factors. These changes may occur, furthermore, without consideration of the implications in regard to health. Cumulative effects of borderline malnutrition are so difficult to identify and may require so much time for recognition that there is constant need to be on guard against trends that involve risks of impaired health.

As a means of detecting and recording either favorable or unfavorable changes in nutritional status, provision should be made for periodic nutrition surveys of representative population samples by teams of experts. Such factual information would be invaluable to legislative leaders, public health officials, educators, physicians, agricultural economists, and those who guide the food industry.

It is hoped that the present monograph will be useful in developing a better understanding of the value and purpose of nutrition surveys and that it will contribute to the development and use of improved techniques for conducting such studies.

With each advance in discovering the nature and function of individual nutrients, scientists are in a better position to appraise the significance of differences in food practices. It is highly probable therefore that surveys will have increasing value in public health research and education in the years ahead.

The manuscripts used as a basis for individual sections in the monograph were prepared originally by individual authors, but extensive revisions were made on the basis of continued study and discussions by all members of the Committee. Hence each section has had the benefit of many suggestions and criticisms, including review by all members of the Board, before reaching its final form. Special acknowledgment should be made of the work done by the following authors in preparing the respective sections of the text: Section I, Dr. Elmer L. Sevringhaus; Section II, Dr. Hazel K. Stiebeling; Section III, Dr. Grace Goldsmith; Section IV, Dr. Herbert Pollack, Dr. Robert E. Johnson and Dr. Robert M. Kark; Section V, Dr. Frederick J. Stare, Miss Elizabeth Caso and Miss Frances McKinnon; Section VI, Dr. William J. Darby; and Section VII, Dr. Walter Wilkins and Miss Ruth Blakely.

C. G. KING, *Chairman*
Committee on Nutrition Surveys.

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Section I

THE OBJECTIVES AND DEMONSTRATED VALUE OF NUTRITION SURVEYS

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In late 1943, the National Research Council published a study (1) prepared by the Food and Nutrition Board which reviewed the evidence, gathered from 189 quoted publications, for dietary inadequacy and nutritional deficiencies in the United States. During the succeeding four years, reports have appeared that include experiences with population groups suffering deprivation of accustomed food intake by some of the vicissitudes of war. Interesting as these accounts are to students of nutrition, they are not comparable in value to the systematically organized surveys which are conducted expressly to secure data showing the distribution of cases of malnutrition. Surveys are also required to measure the comparative nutritive status of groups and communities. The characteristics of surveys can best be presented through examples recently published and therefore of current interest. Any student of the field ought to become familiar with the extensive dissertation (2) by Bigwood, prepared for the League of Nations and presenting a world point of view just prior to the Second World War.

Distribution may be studied from several angles. It has been interpreted in terms of geographic units, as in the North Carolina studies (3) or the Louisiana work (4), and it is of value to consider special population groups, such as the Mexican Indians (5). Populations can be appraised in various ways: requirements may be evaluated at different ages (6); the economic status has been involved in many cases (7); occupational groups became particularly important during the recent war (8); racial groups present special problems that justify their study (9). The adherence to distinct dietary customs or to taboos gives rise to opportunities for interesting surveys (10). Also groups under physiologic stress such as pregnancy (11) (43) (44), or pathologic stress such as complicating disease (12), are special objects of surveys. It is therefore obvious that the group to be surveyed must be defined. Upon the accuracy of this definition and the objectivity with which it can be applied in the field will depend the significance of the results. Such definition must be determined by the ultimate purposes of those who plan the survey.

Even more difficult is that definition of malnutrition which is to be used in a given survey. There are far more possible concepts of malnutrition than there are identified nutrients. The differentiation between excellent and barely acceptable nutrition with regard to any one nutrient adds complication. Marginal deficiencies are harder to detect, although they are apparently more frequent than the full-blown syndromes (13). A choice of standards which distinguish the bad from the acceptable states of nutrition must be made deliberately and in advance of the observations. This task is often more difficult than making the observations. Because there are numerous sources of disagreement among experienced students of human nutrition, free discussion on these matters should be invited in the planning of a survey, but ultimately the decisions about details should be made by a very small group to facilitate agreement. Since the detailed diagnostic standards are to serve for a specific survey and may not be permanently accepted standards, it is imperative that they be stated explicitly. Noteworthy efforts in this direction have been made by the U. S. Public Health officers (14). Further precautions include group training of the examiners if there are more than one. The experience of the team which studied a Newfoundland coastal group (15) gives eloquent testimony to the varied interpretations which even experienced examiners can place upon technical terms.

Most published results of nutrition surveys indicate that the purpose was to discover deficiencies of vitamins. The criteria for these deficiency states have included: (1) visible lesions supposedly associated with specific vitamin deficiencies; (2) laboratory data (such as blood concentrations, urinary excretions, or roentgenograms) showing conditions below accepted standards; or (3) food intake which compares unfavorably with published standards. The variety which the third approach may take has been reviewed by Stiebeling (16). The techniques of dietary surveys require clearer definition of their limits of precision, such as the evaluations made by McHenry and his co-workers (17) and by Kaser et al. (18). Furthermore, the reliability of a given method of dietary study should be ascertained for each region in which it is employed. The usefulness of such tabulated observations is greatly increased when two or all three criteria are applied in the same survey. Military organization has provided interesting examples of this combined approach (19). Recently some studies which are essentially surveys have incorporated treatment programs. This allows use of a fourth criterion, i.e., the results obtained by supplying specific nutrients in known dosage to those individuals whose evidences of deficiency have been recorded before therapy (20).

The aim of many surveys has been to demonstrate that certain lesions are resultants of specific deficiencies. Frequently the conclusions have been challenged, on a variety of grounds (21). The exact relation between one type of lesion and the supply of a specific nutrient is seldom constant in a large series of persons (22). This may be due to varying individual needs or variable intake of the foods carrying the particular factor, to the duration of the deficiency state (23), or to the participation of other conditioning factors. Among these last are varieties of trauma to tissues and also deficiencies of other nutrients. Recent reports reveal increasing

realization of multiple deficiencies in spontaneous malnutrition (24), (25). Critical studies have shown that some lesions formerly thought to be specific indicators of single deficiencies can be produced by causes entirely non-nutritional, or can be cured by more than one vitamin (26). It has become evident that the therapeutic method can contribute much to the solution of the question if it is applied with adequate control series (27). By the very nature of the survey, designed to determine the nutritional status at a given time, this therapeutic technique is seldom possible. Consequently there is decreasing interest in using a survey as the method for detecting hitherto unrecognized clinical deficiencies and demonstrating their association with dietary intakes. The problem is made simpler, when the ultimate aim of a survey is to determine the distribution of probable deficiencies so that improved nutrition can be provided (28) (29). Theoretically there should be added to the criteria already mentioned a comparison between two groups, one of them supplied with generous amounts of the nutrients in question. Practically, the latter requirement is often supplied by the experience or general knowledge of the observers or of the readers of the survey. When the differences are not obvious, the survey is greatly improved by providing for explicit comparisons of two groups, adequately and suboptimally nourished (30). When the population to be studied in a survey has been subjected to prolonged or profound dietary restrictions, the criteria applied in physical examinations or chemical tests need not be as highly refined as when surveys are made of better-fed people. Thus, for example, such simple history-taking and physical examination as were possible for interned physicians working among fellow prisoners in oriental prison camps (31) enabled them to make valuable observations about "burning feet," a syndrome which is probably produced by a deficiency of pantothenic acid (32). Stringent requirements for correlation of lesions with single causative deficiencies can be relaxed in most surveys which aim to secure programs of better feeding for the surveyed population. This comes about since the deficiencies are seldom single. Usually it suffices to demonstrate the frequent occurrence of disorders of a group type, such as those due to inadequate intake of the B complex, rather than to prove deficiency of thiamine or of riboflavin separately (33). Therapeutic measures sought will usually provide improved intake, either of all the recognized nutrients (34) or at least of the several factors which are commonly associated in deficiency states.

It is possible to employ the survey technique in order to determine the minimum additions to a dietary program which will accomplish desired improvement in clinical condition. The technical problems involved have been carefully presented by a group of experienced students (35). Definition of lesions or of biochemical evidences must be as rigorous as possible. The group studied should be a population which will probably undergo a minimum of gain or loss in numbers, essentially an institutional population or an isolated community. Provision must be made for very careful statistical treatment of the data. Statistical methods are not a substitute for exact observation and recording; without exactness statistical methods are seldom justifiable. Precautions to ensure appropriate sampling are requisite unless the entire group is to be examined. Organization of the entire program in con-

sultation with one trained in statistical methods may reduce wastage of effort. So, for example, it is possible to determine in advance the number of observations which will provide the desired degree of probability for any correlations to be established.

Perhaps the earliest surveys of nutritional status were the recordings of weight, correlated with height, age, and sex. These had an urgency supplied by the actuarial interest in the relationship between weight and the prognosis for morbidity from tuberculosis. Other chronic disorders came to be related to these same data. Later the pediatricians took up this approach as a measure of appropriate feeding of infants and children. Anthropometry as a detached and academic scientific approach provides many contributions. These are often stated as correlations with racial or geographic background, seldom with any nutritionally useful correlates.

For study of the relationships between height, weight, and age, suggested abbreviated standards will be found in the appendix to this chapter. There likewise will be found further bibliographic data for anyone desiring information on special populations or on more elaborate methods. Recent interest in such anthropometric data has become greater as the result of a number of observations made during and subsequent to the Second World War (36). For example, members of the Italian Medical Nutrition Mission, affiliated with the United Nations Relief and Rehabilitation Administration, in studies in Italy during 1945 became convinced that there was a significant reduction in stature for age of children from infancy through the adolescent years.[1] In order to validate and quantitate this impression, statistical methods would be required. Unfortunately the only data for a fair comparison with 1945 observations made in Naples were the reports published by a series of Neapolitans who had studied basal metabolism among children during the 1933 to 1940 period. By ignoring the probable differences in sampling between this group and the 1945 study, as well as other sources of error, it was possible to show that children in the first decade in 1945 were below the weights and the heights of the earlier period by approximately two standard deviations of the 1933–40 data. Although this leaves much to be desired as a careful estimate of the effect of malnutrition upon stature, it cannot but indicate the existence of the problem among Italian children. It is of interest to note at this point that certain clinicians, trained to make observations on nutritional status, had seen these Italian children but had been totally unimpressed with significant deviation from normal bodily build (37). Apparently, their attention was preoccupied with the lack of frequent emaciation or even evident thinness. The Italian children, who tend to plumpness (by American standards) when food is plentiful, had proportions between stature and weight which were not surprising to American observers. The Italian parents and physicians complained of the reduced weight of the children. It was only by applying the rough statistical methods and using standards of children in the same locality before the war that the stunting was made evident.

Analogous experience has been reported[2] from German children during 1946–47,

[1] Sevringhaus, Elmer L.: Unpublished observations.

[2] Gunther, Mavis: Unpublished observations. Personal communication.

and from Malaysian children during late 1945[3]. Although there were no satisfactory standard data on stature and weight of these Malaysian children, a helpful experiment was carried out in so short a period as ten weeks of feeding. One group was given a modest supplement of milk, another group the milk plus additional food chiefly as a source of calories. The increments in height of the groups were 0.35 and 1.13 inches respectively, and of weight 1.45 and 5.3 pounds. Improvement occurred likewise in the "specific signs" of vitamin deficiencies. Although these data offer no surprise to those grounded in animal nutrition experiments, they served to convince the local authorities of the existence of a problem in nutrition which could be met by simple and available means when the Japanese occupation had been terminated.

The pre-existing standards for stature rendered the German observations more useful as data for subsequent scientific studies. Yet it is significant that in all three cases, Italian, German, and Malaysian, official and trained medical observers had denied the occurrence of marked nutritional handicaps in these populations after rapid and immediate inspections, whereas the subsequent measurements and comparisons with previous data gave evidence that the malnutrition coincident with the wartime conditions had left an inescapable mark on stature of children.

In addition to urging the careful recording of data and the statistical planning and treatment of the records contributed by such reports, another suggestion may be made. Those who have been involved in making the surveys just mentioned have become increasingly aware of the existence of great divergences in stature, in resistance to infectious diseases, in economic productiveness, and in initiative as individuals and groups. If the loss in these factors, which has been so evident in war-torn countries in even a brief period of a few years, is contrasted with the known increase in stature of American college students during the past 30 years (38) as well as with the decreasing morbidity from infectious disease and decreasing mortality among infants and children in America and Western Europe, some suggestions about nutritional surveys and therapeutic trials appear pertinent.

For example, may the supposedly racial types of stature and economic competence be in fact merely reflections of long-continued suboptimal nutrition? Such a question could be answered by a carefully planned combination of surveys with long-sustained therapy. It is not too difficult to find communities in Europe and the Orient where the population has little exchange of personnel with the nearby regions. If accurate data were recorded before and during a period of a few years of supervised supplementary feeding in one community, and other communities were compared as untreated controls, it would be possible to determine the importance of nutrition in some of these matters. If the experiment were planned on a broad enough scale, it is conceivable that relative physiological and economic advantages of different supplements could be determined. Thus the problem of which is the preferable adjuvant to a predominantly cereal diet—i.e., cereal germ, soya, or sun-flower seed—could be determined in the human where its solution is of the

[3] Bourne, Geoffrey, H.: Nutrition in Malaya under the Military Administration. Unpublished report. Oct., 1945.

greatest importance. The advantage of a minimal amount of milk solids could be measured. Variations on this theme are numerous (39). The acceptability of the amended food patterns could be determined objectively (40). With planning of nutrition in world-wide terms, it is possible to accomplish important ends by experimental feeding which will harm no one and yet may secure information of tremendous importance, especially since a supply of generous amounts of high quality protein and of naturally occurring vitamins is not within sight.

Surveys have served to arouse the medical profession to recognize the existence of considerable numbers of individuals who suffer from malnutrition (41). An im-

TABLE 1

HEIGHT—AGE TABLE

(Gray and Ayres)

AGE (YRS.)	BOYS		GIRLS	
	Av.	S.D.	Av.	S.D.
1	(18) 751.67	40.17	(12) 754.17	45.55
2	(21) 896.19	36.58	(21) 854.29	33.32
3	(28) 967.50	38.51	(23) 959.13	43.03
4	(34) 1046.76	53.13	(34) 1035.29	37.59
5	(74) 1111.76	43.13	(51) 1110.78	43.65
6	(114) 1185.88	48.50	(74) 1180.54	44.84
7	(143) 1247.24	52.31	(90) 1241.00	47.61
8	(147) 1310.65	52.81	(100) 1307.40	56.16
9	(167) 1358.35	58.10	(122) 1359.10	59.01
10	(173) 1411.88	51.31	(110) 1401.18	60.87
11	(201) 1454.35	66.17	(139) 1460.54	69.90
12	(247) 1503.50	67.37	(126) 1520.24	74.72
13	(293) 1564.49	72.88	(124) 1571.93	72.38
14	(373) 1624.14	77.93	(108) 1601.11	68.23
15	(362) 1684.61	77.32	(96) 1629.79	58.90
16	(292) 1728.43	67.10	(86) 1629.42	54.10
17	(229) 1751.68	61.45	(86) 1639.19	62.37
18	(129) 1761.51	63.99	(51) 1637.25	39.31
19	(52) 1763.46	57.22	(13) 1646.15	46.50

1) Each year is a mid-point, e.g., 2 yrs. = 1.5–2.5, and so on.
2) Numbers in parentheses = size of sample.
3) Measurements are in millimeters. (1 in. = 25.4 mm.)

portant example is the demonstration of the nutritional background for the occurrence of several of the hazards of childbirth and infancy (42) (43). Surveys have made large contributions toward convincing public authorities of the need for governmental interference in commercial practices to ensure better food supplies (44). The information required for educational efforts to improve food selection and preparation by the civilian public (16) or by the military authorities (45) has been derived in large part from surveys. These goals are worthy of further application of effort. The technique for a particular survey may well be determined by the choice of one or more of these goals. As the knowledge of nutrition becomes more

complex the surveys of the future ought to be planned with greater definition of conditions observed, broader training of the observers in the conditions which may be correlated with malnutrition, and more careful statistical preparation for the collection and treatment of the data (46).

APPENDIX

The height-age (table 1) and weight-age (table 2) have been suggested by Prof. W. M. Krogman, Graduate School of Medicine, University of Pennsylvania, because they are considered representative. They were derived from a cross-section of

TABLE 2

WEIGHT—AGE TABLE

(Gray and Ayres)

AGE (yrs.)	BOYS		GIRLS	
	Av.	S.D.	Av.	S.D.
1	(18) 10.89	2.00	(12) 10.25	1.20
2	(21) 13.43	1.44	(21) 12.48	1.14
3	(28) 15.29	1.30	(23) 15.13	2.07
4	(34) 17.27	1.92	(34) 17.35	1.92
5	(74) 19.64	2.15	(51) 19.53	2.23
6	(114) 22.22	3.01	(74) 22.41	2.96
7	(143) 24.64	3.25	(90) 25.14	2.86
8	(147) 27.92	3.98	(100) 27.90	4.83
9	(167) 30.89	4.78	(122) 31.76	4.82
10	(173) 34.45	5.17	(110) 35.17	6.40
11	(201) 37.62	5.82	(139) 39.12	7.24
12	(247) 40.68	6.59	(126) 43.69	8.23
13	(293) 44.77	7.57	(124) 47.92	8.29
14	(373) 49.35	8.06	(108) 50.74	7.98
15	(362) 56.01	9.25	(96) 54.48	7.72
16	(292) 60.64	8.87	(86) 55.71	7.63
17	(229) 64.27	8.42	(86) 56.99	7.10
18	(129) 66.14	9.78	(51) 57.36	5.81
19	(52) 67.15	7.73	(13) 58.15	4.72

1) Each year is a mid-point, e.g., 2 yrs. = 1.5–2.5, and so on.
2) Numbers in parentheses = size of sample.
3) Weights are in kilograms (1 kg. = 2.2 lbs.)

North American middle-class population, predominantly of northwestern European ancestry. These tables are taken from "Growth in Private School Children," by H. Gray and J. G. Ayres, University of Chicago Press, 1931.

For a compilation of extensive data on anthropometry from various countries reference should be made to "Growth of Man", by W. M. Krogman, which is Vol. 20, pp. 1–963 of Tabulae Biologicae, published by W. Junk, The Hague, Netherlands.

For recording changes in height and weight during surveys before and after nutritional therapy, attention is directed to "The Treatment of Growth Failure in Children", by N. C. Wetzel, published by N.E.A. Service Co., Cleveland, Ohio, 1948. This explains the use of the Wetzel "Grid."

BIBLIOGRAPHY

1. Food and Nutrition Board: Inadequate Diets and Nutritional Deficiencies in the United States; Their Prevalence and Significance. Nat. Res. Coun. Bull. No. 109, Nov. 1943. Reprinted in Am. J. Digest. Dis., *11:* 9–34, May, and 9–11, June, 1944.
2. Bigwood, E. J.: Guiding Principles for Studies on the Nutrition of Populations. Geneva. League of Nations Health Organization, March 1939.
3. Milam, D. F. and Bell, M. P.: Sources of Principal Nutrients in Diet of a North Carolina Village Population. J. Am. Dietetic Assoc., *22:* 411–414, 1946.
4. Goldsmith, G. A.: Nutrition Studies in New Orleans Area. Fed. Proc., *4:* 263–268, 1945.
5. Anderson, R. K., Calvo de la Torre, J., Serrano, G., and Payne, G. C.: A Study of the Nutritional Status and Food Habits of Otomi Indians in the Mezquital Valley of Mexico. Am. J. Pub. Health, *36:* 883–903, 1946.
6. Pierce, H. B., Fenton, P. F., Wilkins, W., Newland, M. E., and Budge, P. S.: Nutritional Defects Among Children in Vermont. New England J. Med., *233:* 612–617, 1945.
7. Munsell, H. E., Cuadros, A. M., and Suarez, R. M.: A Study of Plasma Ascorbic Acid Values with Relation to the Type of Diet Used in Puerto Rico by Groups of Individuals of Widely Varied Economic Status. J. Nutrition, *28*: 383–393, 1944.
8. Borsook, H.: Nutritional Status of Aircraft Workers in Southern California. III. Effects of Vitamin Supplementation on Absenteeism, Turnover, and Personnel Ratings. Milbank Mem. Fund. Quart., *23:* 113–160, 1945.
   Borsook, H., Dubnoff, J. W., Keighley, G., and Wiehl, D.: Nutritional Status of Aircraft Workers in Southern California. IV. Effects of Vitamin Supplementation on Clinical, Instrumental, and Laboratory Findings, and Symptoms. Milbank Mem. Fund. Quart., *24:* 99–185, 1946.
   Borsook, H. and Wiehl, D.: Nutritional Status of Aircraft Workers in Southern California. V. A Conspectus of the Survey and Its Field. Milbank Mem. Fund Quart., *24:* 251–291, 1946.
9. Moore, P. E., Kruse, H. D., Tisdall, F. F., and Corrigan, R. S. C.: Medical Survey of Nutrition Among the Northern Manitoba Indians. Canad. Med. Assoc. J., *54:* 223–233, 1946.
10. Barnes, G. T.: Preliminary Studies in Nutritional Deficiencies. J. Trop. Med. & Hyg., *50:* 112–119, 1947.
11. Davidson, L. S. P., Donaldson, G. M. M., Lindsay, S. T., and Roscoe, M. H.: Nutritional Iron Deficiency Anaemia in Wartime. Part III: The Haemoglobin Levels of School Children and Pregnant Women in 1944, Compared with the Levels in 1942 and 1943. Brit. Med. J., *2:* 333–334, 1944.
12. Kimble, M. S., Germek, O. A., and Sevringhaus, E. L.: Vitamin A and Carotene Metabolism in the Diabetic as Reflected by Blood Levels. Am. J. Med. Sci., *212:* 574–585, 1946.
13. Darby, W. J. and Milam, D. F.: Field Study of the Prevalence of Clinical Manifestations of Dietary Inadequacy. Am. J. Pub. Health, *35:* 1014–1021, 1945.
14. Sandstead, H. R. and Anderson, R. K.: Nutrition Studies. I. Description of Physical Signs Possibly Related to Nutritional Status. U. S. Pub. Health Rep., *62:* 1073–1085, 1947.
15. Adamson, J. D., Jolliffe, N., Kruse, H. D., Lowry, O. H., Moore, P. E., Platt, B. S., Sebrell, W. H., Tice, J. W., Tisdall, F. F., Wilder, R. M., and Zamecnik, P. C.: Medical Survey of Nutrition in Newfoundland. Canad. Med. Assoc. J., *52:* 227–250, 1945.
16. Stiebeling, H. K.: Techniques of Finding Out What People Eat. Fed. Proc., *4:* 253–258, 1945.
17. Young, C. M. and McHenry, E. W.: Errors in Calculation of Nutritive Value of Food Intake; Comparison of Calculated and Determined Amounts of Ascorbic Acid. Canad. J. Pub. Health, *33*: 224–228, 1942.
    ——: Errors in Calculation of Nutritive Value of Food Intake; Comparison of Calculated and Determined Amounts of Iron. Canad. J. Pub. Health, *34:* 367–370, 1943.
    Semmons, E. M. and McHenry, E. W.: Errors in Calculation of Nutritive Value of Food

Intake; Comparison of Calculated and Determined Amounts of Calcium. Canad. J. Pub. Health, *35:* 286–290, 1944.

8. Kaser, M. M., Steinkamp, R. C., Robinson, W. D., Patton, E. W., and Youmans, J. B.: A Comparison of the Calculated and Determined Calorie and Vitamin Contents of Mixed Diets. Am. J. Hyg., *46:* 297–325, 1947.
9. Kark, R. M., Aiton, H. F., Pease, F. D., Bean, W. B., Henderson, C. R., Johnson, R. E., and Richardson, L. M.: Tropical Deterioration and Nutrition. Clinical and Biochemical Observations on Troops. Medicine, *26:* 1–40, 1947.
10. Oldham, H., Roberts, L. J., and Young, M.: Results of Providing a Liberally Adequate Diet to Children in an Institution. III. Blood and Urinary Excretion Studies Before and After Dietary Improvement. J. Pediat., *27:* 418–427, 1945.
11. Anderson, R. K. and Milam, D. F.: Biomicroscopy of the Eyes in Evaluation of Nutritional Studies. Conjunctival Changes. J. Nutrition, *30:* 11–15, 1945.

Ibid.: Corneal Vascularization. J. Nutrition, *30:* 17–24, 1945.

12. Youmans, J. B., Patton, F. W., Sutton, W. R., Kern, R., and Steinkamp, R.: Surveys of the Nutrition of Populations. 3. The Vitamin A Nutrition of a Rural Population in Middle Tennessee. Am. J. Pub. Health, *34:* 368–378, 1944.

Ibid.: 4. The Vitamin D and Calcium Nutrition of a Rural Population in Middle Tennessee. Am. J. Pub. Health, *34:* 1049–1057, 1944.

13. Kruse, H. D.: A Concept of the Deficiency States. Milbank Mem. Fund Quart., *20:* 245–261, 1942.
14. Metcoff, J., Goldsmith, G. A., McQueeney, A. J., Dove, R. F., McDevitt, E., Dove, M. A., and Stare, F. J.: Nutritional Survey in Norris Point, Newfoundland. J. Lab. & Clin. Med., *30:* 475–487, 1945.
15. Harris, P. L., Hickman, K. C. D., Jensen, J. L., and Spies, T. D.: Survey of Blood Plasma Levels of Vitamin A, Carotene, Ascorbic Acid, and Tocopherols of Persons in an Area of Endemic Malnutrition. Am. J. Pub. Health, *36:* 155–160, 1946.
16. Stannus, H. S.: Some Problems in Riboflavin and Allied Deficiencies. B. M. D., *2:* 103–105, 140–144, 1944.
17. Spies, T. D., Perry, D. J., Cogswell, R. C., and Frommeyer, W. B.: Ocular Disturbances in Riboflavin Deficiency. J. Lab. & Clin. Med., *30:* 751–765, 1945.
18. Robinson, W. D., Payne, G. C., and Calvo de la Torre, J.: A Study of the Nutritional Status of a Population Group in Mexico City. J. Am. Dietetic Assoc., *20:* 289–297, 1944.
19. Biskind, M. S. and Williams, R. R.: Nutritional Survey at a Children's Institution; Incidence of Avitaminotic Lesions and Effects of Therapy. Am. J. Digest. Dis., *14:* 121–130, 1947.
20. Mack, P. B., Shevock, V. D., and Tomassetti, M. R.: Comparison of Meat and Legumes in Controlled Feeding Program. II. Medical, Dental, and Laboratory Observations. J. Am. Dietetic Assoc., *23:* 588–599, 1947.
21. Glusman, M.: The Syndrome of "Burning Feet" (Nutritional Melalgia) as a Manifestation of Nutritional Deficiency. Am. J. Med., *3:* 211–223, 1947.
22. Gopalan, C.: The "Burning Feet" Syndrome. Indian Med. Gazette, *81:* 22–26, 1946.
23. Milam, D. F. and Anderson, R. K.: Nutritional Survey of an Entire Rural Community in North Carolina. South. Med. J., *37:* 597–605, 1944.
24. Rhoads, T. F., Rapoport, M., Kennedy, R., and Stokes, J., Jr.: Studies on the Growth and Development of Male Children Receiving Evaporated Milk. II. Physical Growth, Dentition and Intelligence of White and Negro Children Through the First Four Years as Influenced by Vitamin Supplements. J. Pediat., *26:* 415–454, 1945.
25. Kruse, H. D., Bessey, O. A., Jolliffe, N., McLester, J. S., Tisdall, F. F., Wilder, R. M., and Sydenstricker, V. P.: Principles Underlying Studies of Nutrition Pertaining to the Influence of Supplements on Growth, Physical Fitness and Health, with a Comprehensive Bibliography of the Studies. Arch. Int. Med., *74:* 258–279, 1944.
26. Valaoras, V. G.: Some Effects of Famine on the Population of Greece. Milbank Mem. Fund Quart., *24:* 215–234, 1946.

37. METCOFF, J. AND MCQUEENEY, A. J.: Clinical Malnutrition in Italy in 1945. Nutritiona Status of Selected Population Groups. New England J. Med., *235:* 451–460, 1946.
38. MILLS, C. A.: Further Evidences of Reversal in Human Growth Tide. Human Biol., *13* 363–377, 1941.
——: Oncoming Reversal of the Human Growth Tide. Science, *92:* 401–402, 1940.
39. BLAIR, R., ROBERTS, L. J., AND GREIDER, M.: Results of Providing a Liberally Adequate Die to Children in an Institution. II. Growth in Weight and Height. J. Pediat., *27:* 410–417 1945.
40. ROBERTS, L. J., BLAIR, R., AND GREIDER, M.: Results of Providing a Liberally Adequate Die to Children in an Institution. I. Acceptance of Foods and Changes in Adequacy of Diets Consumed. J. Pediat., *27:* 393–409, 1945.
41. PETT, L. B.: Malnutrition in Canada. Canad. Med. Assoc. J., *50:* 9–14, 1944.
—— AND HANLEY, F. W.: A Nutrition Survey Among the School Children in British Columbia and Saskatchewan. Canad. Med. Assoc. J., *56:* 187–192, 1947.
42. BURKE, B. S.: Nutrition and Its Relation to the Complications of Pregnancy and the Survival of the Infant. Am. J. Pub. Health, *35:* 334–340, 1945.
43. SMITH, C. A.: The Effect of Wartime Starvation in Holland Upon Pregnancy and Its Product Am. J. Obst. & Gynec., *53:* 599–608, 1947.
——: Effects of Maternal Malnutrition on Fetal Development. Am. J. Dis. Child., *73:* 243–244, 1947.
——: Effects of Maternal Undernutrition Upon the Newborn Infant in Holland (1944–1945). J. Pediat., *30:* 229–243, 1947.
44. WILDER, R. M. AND WILLIAMS, R. R.: Enrichment of Flour and Bread. A History of the Movement. Nat. Res. Coun. Bull. No. 110, Nov. 1944.
45. BEAN, W. B.: Nutrition Survey of American Troops in the Pacific. Nutrition Rev., *4:* 257–259, 1946.
——, JOHNSON, R. E., HENDERSON, C. R., AND RICHARDSON, L. M.: Nutrition Survey in the Pacific Theatre of Operations. Bull. U. S. Army Med. Dept., *5:* 697–705, 1946.
KARK, R. M., BEAN, W. B., AITON, H. F., HENDERSON, C. R., PEASE, E. D., JOHNSON, R. E., AND RICHARDSON, L. M.: Tropical Nutrition. Biochemical and Clinical Observations on Troops. J. Clin. Invest., *25:* 927–928, 1946.
46. ANDERSON, R. K. AND SANDSTEAD, H. R.: Nutritional Appraisal and Demonstration Program of the U. S. Public Health Service. J. Am. Dietetic Assoc., *23:* 101–107, 1947.

Section II

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INTRODUCTION

Studies of food consumption are clearly an important feature of nutrition surveys. In fact one of the earliest approaches to an understanding of human nutritional requirements was through studies of the diets of persons in apparent good health. Thus the protein and calorie allowances suggested more than 75 years ago by Voit,

the eminent German physiologist, were said to be based upon studies of the intake of laborers on freely chosen diets. Atwater in 1902 (1) proposed dietary standards in terms of protein and calories for adults of varying degrees of muscular activity. These, too, were based to a great extent on studies of the diets of individuals and boarding house groups in different occupations.

Today, even with the more precise laboratory and clinical procedures in use, knowledge of human requirements for many of the essential nutrients is far from complete. (Since the state of nutrition (barring pathological conditions) clearly is dependent on previous food intake, its maintenance or improvement in the long run must come from food.) Studies of the food consumption of individuals should be part of the appraisal of the nutritional status of individuals. It is important to broaden our understanding of what constitutes "normal" nutritional status and deviations therefrom, to determine the incidence of various deficiencies in the population, and to locate groups whose physical health and nutritional status are exceptional. It is also important to know what levels and patterns of dietary intake are associated with each.

In addition to dietary surveys made among individuals whose nutritional status is being appraised, there also are studies among institutional and family groups, ranging from small spot studies to those of nation-wide dimensions. Data from the latter surveys are of major interest to two groups: (a) those who wish to appraise dietary adequacy in order better to effect improvements in diets, and (b) those who seek to gauge potential markets for selected foods under various circumstances.

Many of the problems involved in the various methods of studying the nutrition of populations were discussed by Bigwood in 1939 (2). This chapter describes some of the more commonly used methods of collecting and analyzing data on food consumption and points out some of the uses of the results as well as some limitations to be observed in interpretation. The first two sections are devoted to a brief description of types of studies that use different methods to secure the original data regarding the kind and quantity of food that individuals or groups consume. Three sections follow which are equally applicable whether individuals or groups are the subject of study. These discuss some points to consider in the collection, analysis, and interpretation of data. Two additional sections describe methods of analysis that make family surveys serve many other purposes than appraisal of nutrition. The appendix contains pertinent sections of some of the schedule forms that have been used by different workers in the collection of data. They are included here as illustrations of the methods described rather than as recommendations for use.

TYPES OF FOOD CONSUMPTION DATA

Diets of Individual Persons.—Studies of the diets of individuals usually differ from family studies with respect to objective and in the methods used. Interest in individual studies always centers in foods actually eaten (physiological consumption) rather than in both the physiological and the economic aspects of consumption. Information about individual diets and food habits should tie in closely with studies of nutritional status, although the family dietary study can also make an important contribution.

Methods in current use for estimating the consumption of individuals range from a qualitative diet history or food habit inquiry to quantitative laboratory measure of the quantity and composition of the food eaten. Each type of study has its use; the important thing is to consider carefully what kind of facts are needed for a given purpose and which method will provide these facts at the lowest cost.

Dietary History.—This type of study aims to discover the usual food pattern over a relatively long period, as contrasted perhaps with a report of menus followed or quantities of different foods eaten in the previous 24 hours. This method should certainly reveal major deviations from the usual concept of good food habits. It would show up the non-milk drinkers, poor vegetable eaters, and the like. As such, it provides some indication of the direction of educational programs to improve nutrition. Even without any calculations of nutrient content, these histories can furnish a basis for classifying individuals into certain broad groups, for example, those whose diets are obviously poor with respect to one or more nutrients, those whose diets probably are better than the average, and an intermediate group.

Some investigators feel that dietary histories can be obtained with sufficient accuracy and completeness to justify calculation into terms of nutrients and appraisal of the individual's dietary practices.

Estimates of Food Eaten Made by the Individual.—In this method the child or other individual is asked to recall what he ate during a previous period, usually the last 24 or 48 hours. Sometimes he is asked for an estimate of the quantity of each food and various aids—pictures, food models, dishes and spoons of different size—are at hand to help in his judgment. This reporting of a day's food may or may not be accompanied by questions about food habits and whether or not this was a typical day. The greatest value of this kind of information is probably its use as a basis for educational or other programs to improve food habits.

Records of Food Eaten Kept by the Individual.—Many investigators have taught individuals to keep an accurate record of all food eaten during a period which may vary from one to seven days or more. Usually an attempt is made to get information on quantity as well as a full description of the food. These quantitative data differ in degree of precision. The quantity of food may be estimated or actually measured, using common measures; or the subjects may be taught to use balances or scales. Many modifications of this method have been developed to fit a particular need.

It is recognized that in this method, as in others, errors may arise at several points. The subject may fail to measure or estimate carefully the quantities of foods eaten or may keep a dishonest record; the analyst may err in translating the subject's quantitative measures or estimates into units employed in the food table used; the food tables may not be applicable in a given case.

However, several findings indicate that the carefully taken individual food record is of value in nutrition surveys. Darby (3) using 7- or 3-day records kept by individuals which included quantitative estimates of foods eaten found that the mean intakes of comparable populations showed close agreement and that the differences which occurred in segments of these populations were in the expected direction. Thus males consistently had a higher intake than females and the calculated ascorbic acid intakes were greater in higher than in lower economic groups (3), (4).

Finally, the more labile blood constituents, such as ascorbic acid and carotene, varied between groups in the same direction as the calculated intakes of these factors (4). A study of the statistical association between food intake of ascorbic acid and its level in the blood has revealed that the association is significant in three nutrition surveys made in quite different population groups (5). Hence, unless one expects too great accuracy from individual records, they seem to permit reasonably good characterization of the dietary habits of groups.

Laboratory Precision in Measurements of Food Eaten.—For many nutrition studies it is important to have precise information on the nutrient intake of individuals. This may mean a record by weight of food eaten in the home or under controlled group feeding, taken by a person trained in quantitative work who is mindful of and alert to possible sources of error. Actual laboratory analysis may be made of a duplicate of a meal eaten or of suitable samples of food. Because of the labor and cost of such studies their use usually is limited to extensive metabolic studies, or to research groups with special facilities for collection and analysis.

All of these methods furnish a certain amount of information about food habits, and give a more or less accurate indication of the probable nutritive value of the diet. There is need for a critical appraisal of the several methods in use in relation to the results obtained and their interpretation and application. Considerable experimental work comparing the usefulness of several methods in connection with surveys of nutritional status has been done but more extensive studies are needed.

Family or Institutional Dietary Survey.—Three general methods are open to the investigator wishing to study diets of families or other groups of individuals sharing common food supplies. They are:

(1) *Family food accounts.* Simple running reports of food purchased (and produced for household use).

(2) The *food record* which makes use of a weighed inventory of foods on hand at the beginning and close of the study, together with a day-by-day record (by weight) of food entering the home with or without records of kitchen and plate waste.

(3) The *food list*, which the interviewer uses in obtaining from the housewife an *estimate* of the quantities of foods used during the last 7 days.

These methods differ widely in the cost of collecting and analyzing data and in the uses that can be made of the results. In appraising these methods it is taken for granted that well-designed schedules are used, as well as procedures adapted to the habits of the group being investigated, and that adequate training is given to field agents or interviewers entrusted with securing the facts. No amount of analysis can compensate for inadequate original data. The unique characteristics of the methods are first described and then certain problems involved in the methods are considered.

Family Food Accounts.—Day-by-day records of food purchases and food expenditures can furnish valuable facts about family food consumption, especially among urban groups who keep comparatively little food on hand. This method was used during the war by the U. S. Bureau of the Census as a means of getting quick answers on how consumers were spending their ration points. Many farm families keep

such accounts along with records of the food brought into the kitchen from storage or from the farm.

Advantages of this method include its simplicity since it can be easily understood by the homemaker keeping the account, and the relatively low cost of collecting such data. In households with small food inventories, where the diet is fairly monotonous and where food purchasing is pretty much hand-to-mouth, it would be unnecessary to keep food accounts for a long period to get a reliable picture of consumption. In other households, however, food accounts would need to be kept over long periods in order for inventories on hand at the beginning and end of the study to cancel.

Disadvantages include the difficulty of getting a random sample since participants must be willing and able to do the work required. Also interest may lag and participants drop out or become careless in their records to the point of affecting the validity of the results. In addition, the task of summarizing the data is considerable.

Since this method is not generally used in this country as a means of studying family diets, it will not be discussed further in this chapter.

Food Record Method—Quantitative Measures and Inventories.—The main characteristics of this method are the record by weight of food on hand at the beginning and the end of the period of observation, and the daily entry in the record of the weight of all foods coming into the house for household use. In order to maximize the accuracy of entries the trained field agent or supervisor takes the beginning and closing inventory. An accurate balance is left with the family. The homemaker or some other person is instructed carefully on how to make all entries. A record of menus is secured in order to check the reasonableness of food entries. The field agent visits the household frequently, often one or more times daily, to see that entries are properly made.

Even with daily visits of the field agent some omissions may occur. They may be quite marked in some situations; for example, among farm families a large quantity of the fruit consumed may not come into the house, such as watermelon and apples when these are plentiful in the garden or orchard.

Among the methods of securing food consumption data, the food record rates high in the possibility of securing accurate measures of food consumption for individual families as well as averages for groups of families. It has, however, several serious disadvantages. Repeated visits of the field agent may cause the diet to be altered, even though the family is urged to eat as usual. The agent may in fact unconsciously express disapproval or approval of certain types of menu. Her presence may lead the housewife to put on a good front by serving relatively large amounts of expensive foods or, among low-income groups secretly hoping to get material assistance, to deviate in the other direction. So far, no estimate has been made of the frequency or nature of such influences. There is some evidence, however, that families tend to reduce inventory of food on hand at the beginning of the period of observation, since in some surveys closing inventories of food on hand average less than beginning inventories. There is no evidence, however, that this tendency affects the quality or the cost of the diet.

Perhaps the most important limitation of the food record method is the burden it places on the cooperating household. As a result a relatively high proportion of families drawn in the sample may fail to provide a record. The proportion tends to be higher than average among families where the woman is away at work during the day, the homemaker is over 50 years of age, there is sickness or many small children in the family, or a hired cook in the kitchen. In addition, the burden of the method also decreases the likelihood of families being willing to provide another record later on.

One other disadvantage of the food record method is high cost, both in field collection and later tabulation. The repeated visits of the field agent, the high percentage of the sample failing to cooperate, and the need for assembling food quantities from the daily records all contribute to high cost.

Food List Method—Recall.—In this method a report is secured from the housewife of the estimated quantity by weight, retail unit, or household measure, of various foods consumed during the last seven days. The interviewer uses a schedule covering a complete list of foods. It has an advantage in that only a single and relatively short visit is required. As a result a high proportion of the homemakers contacted are likely to cooperate in reporting consumption, even in a repeat survey. The food consumption pattern is not affected by the continued presence of the field agent. In addition, the cost of this method is relatively low.

Sufficient comparison has not yet been made between the food list and the food record methods to permit definitive conclusions as to their relative accuracy. Such evidence as exists suggests that the food list gives a fairly accurate measure of the food bought or otherwise procured by individual families, though some understatement occurs. The quantity reported may be too small because the person reporting fails to recall that any of a certain food was consumed or that certain uses were made of it. Such omissions are likely to occur even when a carefully designed list is used, and when various techniques are used to help the housewife to recall the kinds and quantities of food used, such as by reviewing menus.

Even when all foods and the specific use of these are recalled, the estimate of quantity given may still be incorrect. However, for this type of error estimates from some families are likely to be too high and some too low, so that for averages for groups of families over-estimates and under-estimates may in large measure be offsetting. Also for an individual family, the over-estimates of some foods may partially offset under-estimates of others so that in terms of various nutrients errors may be less than for individual foods.

Because of low cost and other advantages the food list method has been used widely in obtaining information on the consumption of separate foods by *groups* of families, and in providing estimates of the average nutritive value of the food consumed by the groups. With improvement in technique, further comparison of results obtained by the food list and the food record may indicate the food list to be suitable for describing the diets of individual families. In any case, a bridge from the food lists to the food record can be built, if the chief interest lies in approximations of the consumption of population groups.

Economic Versus Physiological Consumption of Foods.—When foods move to

the family kitchen whether from market or farm or garden, producers and sellers consider them as having been consumed. Not all of these foods are actually eaten by the family that bought them. Figures on economic consumption in terms of pounds of food tend to be considerably larger than physiological consumption, because some food may go into the garbage, to pets, may be carried home by servants, or be put to other use. For convenience in the discussion such food will be referred to as "waste."[1]

In some dietary surveys no information is secured as to waste. The extent to which such waste has been taken into account needs to be noted in interpreting the quantities of nutrients secured in various studies. For example, in the Consumer Purchases Study nonfarm families in the highest food expenditure group report 40 per cent more calories than estimated physiological requirement [(7) Table 44]. Since no account was taken of waste, it seems highly probable for many of these families that much of the food available for household consumption was actually not eaten. The data may represent a true picture of economic consumption but not of physiological consumption.

The food records now being used by the Bureau of Human Nutrition and Home Economics call for a daily estimate of food waste, and the food lists call for weekly estimates. Attempts to get a weighed measure of it continue to be made by some investigators. It is hoped that in time facts will be assembled to give a fairly reliable measure of the extent of food waste in the home. Reports from city garbage collectors suggest that from year to year it is highly variable in weight and composition.

How the question of waste is dealt with and what foods are wasted will affect the estimate of the nutritive quality of diets. In this country calorie estimates will be chiefly affected. Considerable fat in plate waste and drippings, and much stale bread go into the garbage. Only a small percentage of American diets are found to be inadequate with respect to calories, however. Calcium, a nutrient often short in diets, is not likely to be much affected, at least for urban families, unless milk goes to pets. For farm families the milk for the family and for chickens has not always been entirely untangled, so food consumption reported in some surveys may overstate calcium consumption.

Facts as to the edible food fed to animals and thrown away as garbage were obtained in a summer survey of a group of families in Georgia (8). Several diets classified as "satisfactory" before adjustment was made for the food entered in the record but not eaten by the family were classified "unsatisfactory" after such adjustment. Diets of white families of farm owners and tenants who fed their animals larger quantities of milk products than any other food were most seriously affected with respect to calcium and riboflavin. On the other hand, among low-income Negro families of farm sharecroppers and laborers grain products and fats, as well as some milk and vegetables, from the family food supply often went to animals. Their

[1] This concept of waste ignores loss of nutrients because of method of cooking or because of failure to use the cooking water. Such losses are considered in relation to composition values to use in calculating nutrients rather than in measuring pounds of food consumed. Estimates of "waste" of food by consumers using a very broad interpretation is presented by W. Kling (6).

diets therefore were lower in food energy value and ascorbic acid than would have been indicated without the facts about food waste.

Total Food Consumption by Family Members.—Both the food record and the food list are especially designed to get facts on food consumption from families who eat most of their meals at home. Usually data are secured on number and type of meals eaten out and the expenditures for these and other foods eaten away from home by members of the family. In appraising the diet for nutritive quality, it is generally assumed that the food eaten out is similar in character and quantity to what was eaten in home meals. Among families where a large percentage of the meals are eaten out, this procedure is questionable, since meals eaten at home may be quite different from those eaten away from home. Further investigation is needed of the interrelation of food eaten at and away from home, and some pilot studies may well be undertaken.

To supplement data secured on food eaten out of the family food supply with a report on the additional quantities and kinds of foods eaten by family members may greatly increase the complexity of the dietary survey. One complication in such investigations is the fact that the housewife who provides the facts on the food eaten out of the family food supply—including lunches taken from home—usually does not know about the other foods consumed even when she knows how much money was spent for them. Facts about meals and other food purchased and eaten away from home thus must be secured from the members who consumed it. This may mean extra visits to interview the family members, or giving instructions to the homemaker for obtaining the information from these members. The method used might be that of recalling quantities of various foods eaten during the last day or two, or of keeping an actual record at the time the foods are eaten. Special techniques would be needed to get reasonably accurate estimates of quantity. It would be desirable also, but often impossible, to have data on ingredients in mixed dishes eaten away from home.

While it is perfectly feasible to obtain this information about foods eaten away from home by family members, the data themselves will seldom be as accurate as those on food consumption in the home obtained by the food record method. Furthermore the quantities will be on a different basis, foods "as eaten" rather than "foods as brought into the kitchen" which means special handling in computations and analysis. Nevertheless the increase in the proportion of meals eaten away from home makes this supplement to the family dietary survey increasingly urgent.

Distribution of Food Among the Family Members.—A dietary survey that gets facts only on the total quantities of food consumed by families tells nothing about the distribution of foods among family members. Observation suggests that it is not always distributed on the basis of need. Facts about distribution within a family for the most part call for special studies, although it is sometimes feasible in family dietary surveys to get some facts about it along with the usual facts on total family consumption. This has been done, for example, in a dietary survey made by the Bureau of Human Nutrition and Home Economics during 1946 and 1947 in Cumberland, Maryland, of families with school children in the third to the sixth grade. Facts bearing on distribution included menus, recipes, and quantity in

household measure of each food eaten at home by the children in the third to the sixth grade.

SOME POINTS TO CONSIDER IN COLLECTION, ANALYSIS, AND INTERPRETATION

The Sample—Size and Representative Character.—The method chosen and the sample needed should be planned in the light of the kind of questions for which answers are sought, the response to be expected from consumers from whom facts are requested, and the funds available for both the field collection and the later processing of the data. The matter of purpose or use of the data is complex because dietary data have multiple uses that develop in part as the potentials of the data collected are recognized.

Many questions are likely to arise. In family studies, for example, it may be important to consider whether the descriptive data needed should cover all housekeeping families, or whether it might be desirable to concentrate on getting facts and figures designed to measure the effect of difference in income, family size, season, place of residence. If the latter seems best, it may be advisable to limit the types of family included. By getting a more homogeneous group the data will be more suitable for certain types of analysis.

The size of sample needed turns on what classification is to be made in analyzing the data and what foods are in need of special study. The lower the variability in consumption of a given food among families or individuals, the smaller is the number of families or persons needed to give stable averages. Because of the wide differences among foods in variability of consumption it will probably never be possible to have samples in family dietary surveys large enough to permit extensive analyses of all foods.

Random samples, in which every consumer or consuming unit has the same chance of being included in the study, are useful for describing the larger universe from which they are drawn. Non-random samples can also be used for this purpose if the distribution of characteristics in the larger universe that have a bearing on food consumption are known and if the non-random sample provides measures of consumption in terms of these. Even when non-random samples cannot be used as a basis of state and national averages, for example, they may if carefully used provide very valuable data for a study of the factors affecting food consumption and also of the nutritive value of the diet in relation to the known or estimated needs of the consuming groups.

In order to maximize the usefulness of data secured in surveys, it is highly important that the method of selecting the consuming units be fully described, along with facts as to those consumers drawn in the sample who were unwilling or unable to provide the information requested. Analysis may include a comparison of the characteristics of the sample with those of other samples or censuses. The U. S. Bureau of the Census publishes population characteristics and agricultural data showing many of the items by small geographic units, such as counties and townships. Appraisals of the sample are usually included in reports of surveys, such as those made by the Bureau of Labor Statistics (9) and the Bureau of Human Nutrition and Home Economics (7).

The Time Period to Which the Diet Relates.—Two aspects of the time period covered by a dietary survey seem especially important: (a) the difference among seasons, and (b) the day-by-day and week-by-week variability in diet quite apart from seasonal change.

Seasonal Difference.—Diets may vary greatly with season even in highly urbanized areas drawing food from many regions. This has been indicated by Stiebeling and Phipard in a study of diets of city workers' families in 1939 (10), and by studies of the Bureau of Labor Statistics (11). Even more variation occurs in rural areas where there is greater dependence on local or home-grown produce. Differences between fall and spring diets in rural Tennessee were shown by Kaser *et al.*, (12). Milam and Darby (13) presented data on food consumption in four seasons in a rural county in North Carolina. In addition, Milam (14) pointed out the seasonal changes in vitamin C blood levels which obviously reflect differences in seasonal intake.

These studies give some basis for gauging the effect of season on the nutritional quality of diets. Relatively little has been done, however, in following a group of families or individuals through the various seasons and getting a measure of the relative adequacy of average diets at different times during the year. In one such study in Czechoslovakia, the consumption of individuals in a farm family was recorded throughout an entire year (15).

The Bureau of Human Nutrition and Home Economics is at the present time comparing data from a small group of families in two seasons in one year so that diets in the two seasons may be compared family by family. A similar study of four families at four seasons was made several years ago.

In planning studies, then, to get an annual or even a complete seasonal picture, the collection of schedules should be spread throughout the year or season. Sometimes, however, it may be desirable to get seasonal extremes for comparative purposes, a sample of schedules then being taken at the height of each season. In any case, careful attention must be given to timing and selection of families or individuals in order suitably to diffuse other factors likely to affect consumption.

Day-by-day and Week-by-Week Variability.—If it should be determined that every day or every meal should carry a balance among certain nutrients, then it is important to get day-by-day reports. If it is sufficient, however, to have the diet adequate over a period of a week or longer, then the question is how long a period should the data cover in order to be sure that the average consumption per day or per week is a measure of customary behavior within a given season. In some societies the food may be so monotonous that a report covering a day or perhaps two at the most, along with feast periods coming a few times a year, may give a reasonably complete story. In the United States, however, a weekly pattern of food consumption is quite pronounced. As a result a period of at least a week is felt to be desirable to get a measure of the percentage of families having diets of a given nutritive quality.

It should be recognized that in any distribution of families or individuals by level of nutrient intake there will be fewer cases in the extremes when the data are

based on seven days than on one or two days. In other words, there will appear to be fewer inadequate diets when the longer period is used.

The question is sometimes raised as to whether a period beyond seven days is needed (16) and if so, what is the best method to use in collecting data.

In a second week cooperation with a family food record would probably be low. A food list covering the past two weeks rather than the past week might result in too low a level of accuracy. It might be feasible to get families to cooperate in giving a 7-day food list for two successive weeks or for two weeks not too far apart. In making such a test it would seem best to keep the weeks within a season.

Nutrients in Diets.—What Nutrients to Measure.—The first question to decide in planning the analyses of any diet record for individuals or for families is which to include of the 40 or so nutrients needed by the body. Some nutrients are so widely distributed among foods or are sufficiently closely associated with others that not all need be considered in equal detail. Which should be considered will depend to a large extent on the nature of the diet. If the nutritive content of diets is to be calculated rather than analyzed, the availability of suitable food composition data must be considered. The investigation should consider also the yardstick to be used in interpreting the nutrient content of the diet. It may not seem worthwhile to calculate the quantities of a given nutrient for which no standards of intake have been proposed. On the other hand, such calculations will show the relative importance of selected foods or food groups as a practical source of the nutrient in question.

Whether or not it is desirable to calculate a given nutrient in a diet depends on whether or not it is likely to be deficient and on the intercorrelation of nutrients. For example, many studies have shown that it is safe to assume that if calcium and protein are adequately supplied, phosphorus also will be provided in sufficient quantity. However, although calories might never be low in a group being studied, it may be of interest to calculate the energy value of diets because of the relationship between energy metabolism or carbohydrate intake and the requirement for thiamine and other B-vitamins.

The intercorrelation of nutrients in diets is a subject which warrants further exploration. Any feasible reduction in the number of nutrients for which calculations are needed will aid in cutting the cost of analysis. It should be realized, however, that the omission of some nutrients may limit the possibilities for re-interpretation in the light of additional knowledge of interrelationships among nutrients.

Calculated vs. Analyzed Values.—Several investigators have compared the results obtained by computations and by analysis of representative samples of the diets being studied. Recognizing that there might be discrepancies, they wished to know how large these are and in what direction.

Results have led some workers to feel that agreement is remarkably good. For example, comparisons of the mean analyzed caloric value of individual diets with those calculated from modern food tables reveal that, despite differences between corresponding individual pairs, calculated and determined means may differ by less than 10 per cent. The agreement becomes better when the number of meals in-

cluded is 20 or more, and when the intakes are measured on the raw basis (12), (17), (18). The calculated and determined means of protein in diets also show good agreement, usually within 5 per cent (17), (19), (18). Calculated values for fats in the diets generally tend to be higher than the values obtained by analysis (17), (18).

As to minerals, the reports of Widdowson and McCance (19) and of Hummel *et al.* (18) indicate that the calculated means of potassium are in excellent agreement with the analyzed means. The British workers also obtained good agreement for phosphorus, while according to Hummel *et al.* (18) the calculated amount of phosphorus exceeds the determined mean of the diet by 17 per cent. The use of calculations for determining the calcium and iron content of diets is somewhat more problematical. Semmons and McHenry (20) found for their 21 meals that the calculated means tend to exceed the determined means. This same tendency was observed by Gutman and Low (20) and Hummel and co-workers (18). On the other hand, Widdowson and McCance (19) found the opposite tendency, the analyzed values tending to be higher than the calculated. They attributed the discrepancy to the hard water used for cooking. When soft or distilled water was used for cooking, they obtained good agreement. According to them, the daily intake of calcium from water averages 75 mg. in England and may go up to 200 mg., depending upon the "hardness" of water. Actual intake of iron may exceed the calculated amount in the diets because of contamination during the process of food preparation, or because of differences in locality (19), (22). Kaucher and others reported the calculated to be approximately two-thirds of the actual intake in an iron-rich locality. On the other hand, for the 21 meals analyzed by Young and McHenry (23), the calculated content exceeded the actual mean content of 6.3 mg. by a difference of 0.6 ± 3.1 mg.

Perhaps the greatest discrepancies have been found and are to be expected in vitamin values because of wide natural variations and chance for loss in the handling of foods. Calculated ascorbic acid intakes are likely to exceed the actual determined values, particularly if the food tables employed are based upon uncooked foods (24), (12). When proper allowances for cooking loss are made and the means of a week's meals compared, the agreement between calculated values and determined values is brought within chance error, particularly when population groups are considered (12). Comparisons between the calculated and determined values of mixed diets for vitamin A, thiamine, riboflavin, and niacin indicate that, despite marked discrepancies which are sometimes found between the values for individual diets, the mean calculated figures may yield useful information for classifying a population into broad levels of intake.

When methods of analysis improve and more data are obtained on the effect of processing on vitamin content of foods, so that tables of the average composition of foods as served are available, the calculated values may agree more closely with the actual intake and become more useful.

In conclusion, it appears reasonable to agree with Widdowson and McCance (19) that "The results are considered to be sufficiently close to warrant the use of food tables in dietary surveys." This presupposes that the food intake is accurately

measured, the length of period of study is sufficiently long, and proper food tables are applied. A food table is only valid for dietaries where the foods are similar in composition to, and are at the same stage of processing as, those from which the tables are derived. When nutrient values based on raw foods are used in calculation, the results should not be expected to agree with an analysis of foods as eaten, cooked or otherwise prepared.

Information on Food Values.—Carefully prepared and properly used tables of food composition are important in describing the nutritional quality of food supplies. Basic food composition values for calculating nutrients in foods as they come into the kitchen are available in a publication prepared in 1945 by the Bureau of Human Nutrition and Home Economics in cooperation with the National Research Council (25). Other sources of information exist and are used by some investigators in this country. Among the more commonly used sources are the tables of Bowes and Church (26), Taylor (27), Bradley (28), and Sherman (29). Values in the various tables are not always the same.

In other countries average composition figures for many foods are quite different from those used here. Some of the differences reflect real variations in the foods themselves. Others result from differences in methods of calculation from analytical data. For example, in the food tables commonly used in Great Britain figures for carbohydrates represent what is reckoned as available to the body for food energy. In the United States tables, total carbohydrate (by difference) is presented. As a result, quite different calorie values for a given food may be used in the two countries. These differences become of great practical importance in international programs involving calculations of food supplies and food requirements in terms of calories. The bases for computing calorie values were thoroughly reviewed by a committee convened in February 1947 by the Food and Agriculture Organization of the United Nations; suggestions were made as to the most satisfactory procedure for present-day use (30).

Variability in Food Values.—In deriving the average values presented in U. S. Department of Agriculture Misc. Pub. 572, the objective was to obtain representative figures for foods as used in this country the year around. Some of the averages in these tables rest on a large body of data and can be considered fairly stable. Others cannot be as well established until more analytical work is done.

Great variability exists in the nutrient content of foods, particularly for minerals and vitamins. Variety, soil, weather, and other cultural conditions, and length and kind of storage, are among the factors affecting the quantity of a nutrient in a given kind of food. Processing and methods of household preparation for eating exert still further influence. For some foods sufficient data are available for a study of the effects of some of these factors, and to provide separate averages for a specified type of condition. Take, for example, the vitamin C content of potatoes, an important item in diet calculations. In deriving the average value, 17 mg. per 100 gm. given in Misc. Pub. 572, over 1,100 analyses were examined. Individual samples ranged from as low as 4 mg. to as high as 40 mg. Data were available for studying losses in storage for varying periods. Thus the mean value for freshly dug potatoes was 24 mg. while for those stored 5 to 6 months it was 10 mg. per 100

gms. The development of a single figure for general use became a matter of appropriate weighting of values for fresh and stored potatoes of the important commercial varieties.

Nutrient losses due to cooking and other food preparation practices have been studied extensively in recent years. Enough is known to permit some rough adjustments to be made in dietary calculations to allow for these losses. However, the large number of variables to be taken into account and lack of information about food practices in the home are reasons why more precise allowances cannot as yet be made in calculating diets. When dealing with family food supplies, it may be desirable to compute the nutritive value with and without this adjustment. This permits comparison with other studies and easy revision as better information on the effects of food preparation becomes available.

When estimating the nutritive value of an individual's diet, food consumption data usually are in terms of food as eaten. Nutrient losses must then be taken into account in preparing the food tables to be used in calculation.

A question that faces every investigator is what, if any, adaptations of general food composition tables should be made for a particular study. In line with the objective of using the most representative figures for the diets being studied certain refinements are possible, particularly where studies are seasonal, local, and comparatively small. It might even be desirable to have special laboratory analysis of locally produced foods important in the diet of the group. The use of special values may be more important for diets of farm than of city families whose food supply in large part comes from diverse sections of the country. For example, values for raw instead of for pasteurized milk might be used in calculating farm diets. Season probably has a greater effect on the nutritive value of farm than of city diets. Different values for vitamin A in summer and in winter home-produced butter might be used. In the late winter or spring months, the average length of storage of potatoes eaten by farm families is much greater than that of potatoes eaten by urban families.

With each dietary study, the investigator wishes to use the most up-to-date and suitable food values. Food composition tables are revised frequently as more and more knowledge becomes available. But this frequently means that results of current and earlier studies are not directly comparable without recalculation. This underlines the importance of reporting in detail the quantities of food consumed. Recalculations can then be made as desired. It is important too that the factors used in calculating nutrients be included in the report or that reference be made to them if they are in a published table. Some estimates can then be made of the differences introduced by the use of specified nutrient values.

Nutritive Value of Mixed Dishes.—One source of error in dietary calculations is in estimating the nutritive value of mixed dishes. This problem is of special importance in the menu method of inquiry in which an individual estimates the quantity of each food eaten at a meal. It is almost impossible for him to know the kinds and quantities of ingredients in mixed dishes served at home and especially in public eating places.

In the family food record method, the housewife can supply the recipe for any mixed dishes on hand in the beginning or ending inventory and the ingredients can

be figured with the household supplies. Estimates must still be made for mixtures which are purchased, such as baked goods, canned stews and soup mixtures, chicken and noodles, meat and bean combinations, and an ever increasing assortment of other food products. There is no standardization of preparation of these foods and the development of suitable food composition values presents a real problem.

Use of Group Values.—Short-cut methods of calculating diets, using weighted values for groups of foods closely related in nutritive value, have been reported by several workers (31), (32), (33), (34). Such a method has been used for over 15 years in the Bureau of Human Nutrition and Home Economics in the development of plans for adequate diets. Any technique which reduces the number of calculations saves time and cuts costs and should, therefore, be considered as a possibility.

The total amount of time saved depends on the number of diet records to be calculated. It is assumed that the results are to be studied diet by diet and not combined to give group averages only. Otherwise there would be little or no economy in a short method.

The development of appropriate group values requires preliminary study of the food consumption data in order to derive suitable weightings for the items combined into groups. In general, the larger the number of groups the more homogeneous the foods in each group can be, and the better the agreement between long and short methods. Also, the more days represented by the average consumption figures the closer the results obtained by the long and short method will be.

Group values developed in one study for use in one locality or in one season may not carry over to another and frequent testing against the more detailed item calculations is necessary. About 20 years ago the Bureau of Human Nutrition and Home Economics developed a short-cut method of calculating food energy, protein, and 3 minerals in family diets (35). The method was tested out on 121 dietaries (24 from institutions, 47 from farm families and 50 from other families). In every case the short-cut method gave figures for food energy within 5 per cent of the long method; for the 4 nutrients 85 per cent were within 5 per cent. However, when these group values were applied to 116 low-income dietaries from New York City and compared against the long method, agreement was much less good. For example, in the calculations for iron 47 per cent of the dietaries deviated by more than 5 per cent from results with the long method, with individual dietaries ranging from 25 per cent below to 55 per cent above the values obtained by the long method (unpublished).

On the other hand, Donelson and Leichsenring (32) reported several comparisons which showed excellent agreement, especially when means of groups were compared. Such good agreement can be expected only when food habits among the subjects are fairly homogeneous, i.e., when the proportion of specific foods selected within the food groups are similar, and when the food group values are carefully prepared.

Yardsticks of Adequacy and the Appraisal of Diets.—Some Yardsticks of Dietary Adequacy.—When quantities of food are translated into nutrients some yardstick is helpful for assessing the adequacy of these quantities for the people who consume the food. The standard selected may vary all the way from the minimum to prevent deficiency diseases to the amount needed to promote optimal nutrition. The so-called London Standard (36) drawn up in 1935–36 by the League of Nations

Technical Commission on Nutrition, represented the first attempt at international collaboration on dietary standards other than for calories. These standards are still used as a yardstick in many countries. But some other countries have developed different standards which they consider more applicable. In the absence of any generally agreed-upon standards many investigators have developed their own yardstick, or adopted one used by others. For example, the dietary standards developed by Stiebeling and Phipard (10) in 1939 were subsequently used by many other workers. A review of the evolution of dietary standards by Leitch was published in 1942 (37).

In this country the Recommended Dietary Allowances of the National Research Council first issued in 1941 (38) have served a useful purpose in providing a (single) yardstick which most workers in the United States have been glad to use. The objective and the bases underlying these allowances have been clearly set forth. They are intended as a guide in planning adequate diets for individuals or families. This means they were set high enough to provide adequately for the many persons with greater-than-average need. They may represent an unduly liberal margin in planning food supplies for large population groups in which the needs of part of the population are somewhat below the average and part above.

The value of a yardstick is contingent upon its proper use. Its changing character as a result of further research into nutritional needs should be recognized. Diets appraised with the yardstick of 1941 would need to be reappraised to make them comparable with diets appraised using the Recommended Dietary Allowances as revised in 1945 (39). While it is entirely correct to say that a diet or food supply provides the recommended allowances of nutrients for which quantitative suggestions have been specified, it does not necessarily follow that a diet which is calculated to provide these recommended allowances can be called "adequate." For one thing, not all the nutrients known to be needed in human nutrition have been included in the calculations. The allowances have been designed to apply to an average mixed diet such as is commonly eaten in this country. With any great deviation in the type of diet the recommended allowances may not apply. Furthermore, it is sometimes forgotten that the National Research Council allowances represent nutrients ingested and that most tables on food composition in common use in this country for dietary calculations refer to uncooked food as brought into the kitchen.

Recommended dietary allowances, like food composition data, are subject to revision from time to time as knowledge of human requirements unfolds. In any case, they can serve as additional means of description, and results expressed in terms of a standard *should not replace the more basic data—the quantities of various kinds of foods consumed or available for consumption, and quantities of nutrients provided by the food.* All too often the results of dietary studies are reported only in terms of the percentage of some standard of adequacy. Thus, they are tied to a measure which is itself subject to revision.

On the other hand, tables showing the distribution of diets according to the level of nutrient content have permanent value in that they can be interpreted in the light of any yardstick, present or future, in so far as the food composition values on which they are based have not undergone major revisions.

Measures of Nutritional Needs of the Consumers in Dietary Surveys.—Com-

putations of the nutritive value of a diet are expressed in terms of some unit. When diets of individuals are studied this is not a problem since homogeneous groupings can be made and results expressed per individual. For family studies, however, averages per family per week may be compared directly only if the composition and requirements of the groups of families can be adequately described and are homogeneous except for not more than one important variable. Averages per person per day are often used and are easily understood. The usual procedure is to divide aggregate consumption for the week (or other period) by the number of meal-equivalent persons (21 meals = one person for one week) in the household. The per capita unit is generally satisfactory for comparing large numbers of families or homogeneous groups. It is not satisfactory for use in evaluating the diet of a given family nor for comparing diets of families of widely varying composition or activity.

To help in estimating the nutritional need of the individuals or families being studied, certain pertinent data are usually obtained. These include age, sex, height, and weight and may include information as to pregnancy and lactation. Sometimes an estimate of muscular activity is made. When the more accurate family food record method is being used, it is customary in studies of this Bureau to get information from which to gauge relative activity. It should be pointed out that requirements for food energy for an individual are very difficult to judge, and even the most careful estimates based on description secured from individuals may be far from the actual need. Nevertheless, a procedure taking activity, age, height, and weight into account is superior to that of assigning an arbitrarily predetermined value to food-energy standards.

When familites differ widely in composition and occupation, it is more satisfactory to estimate household size in terms of "nutrition units" (10). The "nutrition unit," with a value of 1.00, is usually assigned arbitrarily to the allowance of each nutrient recommended for a man who for size and activity requires about 3,000 calories daily. The values assigned to other individuals represent the relation that their allowance bears to the allowance for this man. Such scales, one for each nutrient, can be developed from the recommended allowances of the National Research Council. Household size is computed in terms of the number of energy units, calcium units, and so on, to fit the composition and energy needs of the family.

The following illustration for a specified family may serve to explain the calculation of household size in terms of energy and calcium units:

PERSONS	RECOMMENDED ALLOWANCE[1]		NUTRITION UNITS	
	Food energy	Calcium	Food energy	Calcium
	cal.	*gm.*		
Man, physically active	3,000	1.0	1.00	1.0
Woman, sedentary	2,100	1.0	.70	1.0
Boy, aged 13	3,200	1.4	1.07	1.4
Girl, aged 9	2,000	1.0	.67	1.0
Household size in nutrition units	—	—	3.44	4.4

[1] Recommended Allowances of the National Research Council, revised 1948 (40).

The effect of changing the recommended allowances for the adult man taken as unity should be clearly understood. For example, the previous allowance (1945) of 0.8 gm. of calcium for adults would have meant that the family listed above was equivalent to 5.0 calcium units instead of 4.4 units. The computation follows:

	gm.	*units*
Man	0.8	1.00
Woman	0.8	1.00
Boy	1.4	1.75
Girl	1.0	1.25
		5.00

The calcium content of this family's diet would calculate to be higher per nutrition unit when the value of unity was 1.0 gm. than when it was 0.8 gm. This illustration indicates the problems that may arise in comparing different studies when calculations of nutrient content are expressed in terms of nutrition units. They are only comparable when the scales of relatives have not changed.

One other problem confronts the analyst in determining whether the family food supply will provide the kind and amount of nutrients needed by the family group. As a rule, little is known about how the food is shared by persons in the household. To get this information adds considerably to the labor and cost of the survey. McHenry (41) in a study in Canada, found that the wage-earner had first choice, or at least came closest to meeting his calculated requirements, the young children next, then the older children, and the housewife. These families were all in a low-income group, but even among the relatively well-to-do, individual food habits and idiosyncrasies can bring about an unequitable distribution of household food supplies. This aspect of family studies needs further investigation.

Using a Yardstick to Appraise Diets.—Having selected a given yardstick to appraise diets, one must also decide what point or points along its range are to be accepted as providing diets of a given quality, perhaps to be described as good, fair, and poor, or as satisfactory and unsatisfactory.

Some investigators report the proportion of diets that provides, or fails to provide, the recommended allowances (NRC) for each nutrient. Others report also the proportion that provides or fails to provide some fraction—70 per cent, two thirds, one half, or other proportion—of these allowances. The important thing is to define what is used and to regard this appraisal as an additional but not basic feature of dietary analysis.

Diets classified as unsatisfactory or poor are usually so designated if they fall below the dividing line in even one nutrient. Some workers have felt that a diet low in one nutrient should not be in the same category as a diet low in several or all nutrients studied. Accordingly, several attempts have been made to develop a composite valuation which would give suitable weight to the several nutrients being studied. Some workers have computed the percentage of some standard allowance of each nutrient and have combined the several percentages into an average, either simple or weighted. In some cases more weight is given to the nutrients most likely to be low in the diets.

Dietary Studies in Investigations of Nutritional Status.—The ultimate test of the adequacy of diets is the long-term nutritional health of the people consuming them. Many nutrition surveys have been conducted in recent years and with the development of more rapid and more reliable methods such studies are expected to increase. A diet history as well as a record of the individual's current food consumption should be a part of the nutrition survey. Often the food record covers only a short period, from one to three days, and may represent varying degrees of accuracy.

The kind of correlation to be expected between dietary intakes and biochemical and other clinical findings has been the subject of much discussion. Lack of correlation between dietary intake and clinical condition may mean inadequate data, including errors in estimates of quantities of foods consumed and composition values of them; it may mean wrong interpretation of dietary or clinical data or both.

Some of the points to be borne in mind in such a comparison include the following: (a) The state of nutritional health at any one time represents the cumulative effect of food consumption over a long period as well as the recent intake of certain nutrients. The diet record may apply to a day or two, or a week. The great variation in an individual's diet from day to day and from week to week may invalidate attempts to closely correlate the two. However, some nutrients, such as ascorbic acid, are not stored in quantities sufficient to carry an individual through long periods of deprivation. In order that blood levels be maintained at their highest concentration, the frequent ingestion of ascorbic acid is necessary. Consequently tests for ascorbic acid levels in the blood may appear to give better correlation with the current diet record than is found in some other measures of nutritional status. Vitamin A, on the other hand, may be stored in quantities sufficient to maintain high blood levels for long periods of deprivation, and hence very little correlation may be found between recent intake and serum concentrations of this factor. Furthermore, signs of vitamin A deficiency may not be seen in individuals with temporarily low dietary intakes of this nutrient.

(b) The errors that may be introduced by applying tables of average food values to an individual's diet for a short period have already been indicated. These errors are magnified greatly if values for foods as they enter the kitchen are applied to foods as eaten. Perhaps even larger errors are inherent in the method of obtaining food consumption data from individuals.

(c) Only within broad limits can a judgment be made as to the adequacy of a calculated or determined dietary intake for a given individual. Wide individual differences in requirements are known to exist and in fact they may vary from time to time in the same individual.

Estimating food energy needs for subjects of dietary studies is particularly difficult. Since the requirements for some of the vitamins are related to energy metabolism, this may help to explain why evidence of vitamin deficiency does not appear in some cases where intake is apparently very low.

For these and other reasons one should not expect complete correlation between dietary intake over a short period and clinical or laboratory findings for an individual. For groups of persons, on the other hand, and for certain nutrients or aspects of nutrition, results may show fairly good agreement.

There is need for more surveys in which information about diets is secured along with facts about the state of nutrition. It is especially important that some of these be long-time studies, providing periodic checks on the same persons, if we are to enlarge our understanding of the relation of diet to nutritional health as measured by nutrition surveys.

SOME ADDITIONAL NOTES ON ANALYSIS OF FAMILY DIETARY SURVEYS

Analysis as it relates to methodology affecting the basic facts secured has already been considered. In this section attention is focused on the quantitative measurement of the relation of various factors to food consumption and dietary adequacy.

In planning the analysis of family dietary data, the analyst needs a broad knowledge of the behavior of families under a wide range of circumstances. In addition, he needs experience in working with the data. Only when these two qualifications are combined in an analyst are the necessary analyses likely to be designed that will peel off, as it were, and measure the effect of one factor after another.

The questions being asked the analyst of data of dietary surveys are many, even when one limits the list to those relating to actual and proposed food-consumption programs. Considerable progress has already been made, especially as to factors causing differences among families at a given point of time. Less has been done in studying the effect through time of various types of change. The former will be referred to as static and the latter as dynamic analysis.[2]

To the extent that sample size permits, data from dietary surveys have in very large measure been analyzed with respect to the following factors: Place of residence, especially farm and nonfarm groups and with some attention to size of city, food expenditure, income, family size and type, occupation of family members, extent of home-produced foods. To a lesser extent the response of consumers to relative prices of foods and changes in these and to food prices in relation to those of other consumer goods has been studied. At the present time there is need for further refinement of the analysis of most factors with special attention to discovering what uniformity if any exists from place to place among families at any point of time and from time to time in a given society. There is also need to compare the results of static and dynamic analysis, especially for such things as income, relative prices, and farm-nonfarm differences.

Because much attention has been given to the importance of income, the need for refinement in the analysis with respect to it seems great. There has, for example, been a tendency on the part of some persons when families are classified by income to ignore differences in family size. In addition, some persons have assumed that the measure of food consumption and dietary adequacy in relation to income as derived from a single study provides a true measure of elasticity of demand in rela-

[2] This discussion is concerned only with the analysis of data from dietary surveys. Single surveys throw no light on the strength of food habits and the nature of attitudes to foods. However, important facts as to diet patterns are secured especially from family food records that include menus and from surveys of individual food consumption. Those interested in the importance of food habits and how to investigate them should consult bulletin of the National Research Council No. 111, "Manual for the Study of Food Habits," a report of the Committee on Food Habits.

tion to income—that is, the response of consumers to a change of income. Definitive analyses have yet to be made.

The need for further refinement in the static type of analysis exists largely because of the multiplicity of factors involved. In measuring the effect of any one factor, complications are often encountered because other factors are not held constant. There are many correlations among the important factors affecting food consumption. For example, when families in the United States as a whole are classified by income, one finds within each income class variations in the size and composition of the families, in the percentage of families living in the various regions, and in the percentage living on farms, in villages, and in large cities (9) (42). The Consumer Purchases Study provided the largest sample ever secured in a dietary survey in the United States. Its potential for analytical purposes is still far from exhausted. However, even it does not permit complete analysis of the food consumption of groups of homogeneous families classified by season, type of community, region, and income.

In the analysis of data from dietary surveys, a major question is how far to sacrifice homogeneity of groups of families in each category in order to get larger numbers per category. It is probable that much can be done in isolating and measuring the effect of separate factors by using smaller and more homogeneous categories than have commonly been used and at the same time depending on the use of the entire sample in regression analysis to indicate the nature of the effect, rather than aiming to get averages for each cell that reflect the true facts of matters being investigated. In addition, insufficient use seems to have been made of multiple correlation. For the latter to be important, short cut methods need to be developed in order to minimize the cost of calculation.

While it is not possible here to review all aspects of the analysis of dietary data that have an important bearing on their interpretation, some of the broad questions as well as some of the analytical techniques have already been considered, and in the discussion that follows problems of classification with respect to family size and composition, expenditures, and income will be considered. These are major factors that lend themselves to statistical measurement within various non-quantitative groupings such as farm or nonfarm residence and occupation. In addition, some analytical problems relating to income and home-produced food are considered, as well as the problem of the statistical investigation of dietary patterns.

Variation in Family Size and Composition.—Diversity in the size and composition of families has always been a problem in consumption studies. The simplest method is to ignore the sex, age, and physical activity and count only persons, preferably on a week-equivalent basis. Families might, for example, be classified into perhaps six family-size groups and within each family size classified again by income. When that is done, the distribution by composition of family differs markedly from one size of income to another, but to a much smaller extent at the different income levels for a given family size (9).

If the sample is too small to permit the double classification by both family size and income, income and consumption averages per family at the various levels of family income can be reduced to averages per head. These averages are likely to

give a somewhat more consistent picture than do the family averages, of the differences that occur if income were the only factor that differed among the categories. This is especially true of urban families, since for these a considerable increase occurs in number of persons per family at successively higher family incomes. However, deflation on a per-head basis tends to understate the difference in consumption that occurs with difference in income among families of a given size and composition.

In the analysis, for example, of dietary data in the light of the provisions of a proposed national food allotment bill, it was desirable to classify families by per capita income. When that was done, the large families, which on the average have a high proportion of young children and have the maximum advantage of economies in consumption that come with the larger group, tended to fall in the lower income categories. Small families, on the other hand, tend to fall in the higher income categories. The measure of elasticity of demand for many foods in relation to income derived by such analysis has a greater magnitude than if averages per head are derived after classifying the entire assortment of families by family income, or if the families are first sorted by size and measures of income elasticity derived for each size of family.

Consumption and Expenditure Scales.—The obvious differences in consumption needs of various family members early led to the development of consumption scales and the measurement of family size in terms of standard units (43). These are of two quite different types. For example, family size has been measured in terms of nutrition units in order to appraise the nutritive quality of diets. These have already been discussed (see p. 26). In addition, scales to measure the cost of providing equivalent consumption for the various family members have been developed for separate foods and services and for total consumption. Only two of these are considered here, namely, food expenditure or value and total expenditure scales. The former have been used to reduce the heterogeneity of family size and composition when the effect of expenditures for, or value of, food consumed is being investigated, and the latter have been similarly used for family expenditures or income.

If they serve the objective in mind, the value of such scales to measure the relative cost of food for different persons is very great. Scales so far developed, however, treat size of family solely as the sum of separate individuals, taking no account of their groupings into families. There seems little doubt that there are certain money economies with larger size of family. While this economy is much more pronounced for total consumption than for food, since housing included in total consumption is a major category of consumption which increases little with family size, even for food there are economies with larger size of family, and measures built up solely from scales of the separate individuals do not take this into account. This fact is indicated by the data given in table 1. The larger the family, the higher the percentage of families having good and fair diets and the lower the percentage with the poor diet at a given level of food expenditures per unit.

It may be possible to develop additional sets of food-expenditure scales that take into account the relative need of individuals separately and in various family combinations. Consumption units derived from scales for individuals as used at present are probably better for many purposes than per capita measures. The data in

table 1 suggest that the expenditures scales used credit the large family with somewhat more units than it should have on a strictly equivalent basis, yet per capita measures would give them even more.

TABLE 1

PERCENTAGE OF FAMILIES OF SPECIFIED TYPES IN VILLAGES AND SMALL CITIES HAVING DIETS GRADED GOOD (OR FAIR) AT VARIOUS LEVELS OF EXPENDITURES PER FOOD-EXPENDITURE UNIT[1]

EXPENDITURE LEVEL PER UNIT PER WEEK AND REGION	FAMILY TYPES[2]			
	1	2 and 3	4	5, 6 and 7
$1.38 to $2.07				
North and West	16	25	28	30
South	30	32	21	41
$2.08 to $2.76				
North and West	57	71	62	70
South	56	62	85	75
$2.77 to $3.45				
North and West	86	89	89	90
South	84	85	89	88

[1] See Miscellaneous Publication 452, p. 57 (7). The higher expenditure levels were excluded because almost all families had good or fair diets.

[2] The family types (7), p. 16 are as follows:

Type 1	Husband and wife only
Types 2 and 3	Husband, wife and one or two children under 15 years
Type 4	Husband, wife, at least one child 16 years or over, and one or more of any age
Types 5 to 7	Husband, wife, and with at least two children under 16 years and some other children

Relation of Family Size and Food Consumption.—Using data from the Consumer Purchases Study and to a lesser extent those from other studies, two types of questions have been investigated: (1) At what income level does each family size achieve a specified quality of diet? (2) How does the quantity of food consumed or food expenditure differ according to the family size when income is held constant?

Data with a dual classification by income and family size or type permit preliminary answers to these questions. For example, it has been found, using data from the Consumer Purchases Study, that among families of two or more the size of income needed to yield the same percentage of families with good and fair diets for families of different sizes could be expressed by the following formula:

$$\text{Log } y = a + 0.62 \log x$$

where y is the amount of the income and x is the number of persons in the family (44). This measure takes into account family composition as it tends to be correlated with family size in a given urban society.

The change in food expenditures with family size while income is held constant has been studied by many. Published data are available for the development of such a measure of the effect of family size alone. When plotted on double logarithmic scales, these show linear relations of family size and food expenditures (45).

Even though considerable advance has been made in untangling the interrelations of family size and type, income, and food expenditures, there is still need for samples of families large enough to permit the analysis of one homogeneous family type at a time in relation to other facts. It may be that as data from various surveys accumulate they can be pooled to permit more effective measurement of differences from one type of family to another.

Current Income Versus Income for a Longer Period.—A dietary study usually covers food consumption for only a short period of time, often a week. The income reported often is that of the preceding year if the survey includes farm families and the preceding month for urban wage earners. Because incomes of families, especially in certain occupational groups, fluctuate a good deal, the question is frequently asked as to how the consumption of food as reported at a given income level would compare with what families would have eaten had all of them in the group fully adjusted their consumption to the income reported.

The assumption is commonly made that consumption and purchase of various goods lag behind change in income. If in a current survey any income class is heavily weighted with people whose incomes have recently increased, it may be that consumption is below what it would have been had the families on the average experienced this income for a longer period of time. The reverse of this condition may prevail if an income class is heavily weighted with families who until recently had a much higher income. The usual assumption is that the lag in consumption is greater when incomes are moving down than when they are moving up; in other words, the resistance to lowering consumption levels is greater than the hesitation in taking full advantage of increased incomes.

Only to a limited extent has this aspect of food consumption been explored and it should receive further attention. It does seem important to note that consumption and purchase of food tend to contract less with reduction in buying power than do the purchases of durable goods such as house furnishings; the use of the latter can be prolonged.

The bearing of year-to-year fluctuations in income, along with the difficulty of separating capital investment from farm expenses in getting a measure of net money income, has long been recognized as responsible in part for the very low income elasticity of demand for food found among many groups of farm families. The negative and very low positive income categories may include some well-to-do farm families who are classed as having low net money income, as a result of such farm expenses as the purchase of a tractor (or incurring a debt in order to acquire it). In this class also are farm families whose incomes are low because of recent crop failure. Consumption may be only slightly related to current income because such families may have large reserves on which to draw.

Year-to-year data from panels of farm families in midwest States show some of the dangers of interpreting current income as an indicator of the relation of income in general to consumption. In Kansas, for example, the correlation of average annual expenditures for food with current annual income for the years 1934 to 1941 was very low.[3] A higher correlation exists if the net income of the current and the

[3] This analysis is based on data in annual reports of accounts of Kansas farm families published by Kansas State College.

preceding year were averaged. A still higher correlation was found with the gross income of the current and the preceding year. These higher correlations are partly due to the fact that Kansas farm families receive their income irregularly—the larger portion of their annual income is received during the last six months of a calendar year.

Home-Produced Food.—Home-produced food is usually important among farm families and introduces certain complications in dietary analysis. In most dietary surveys, the home-produced food is given a dollar value that is included along with the food purchased in the dollar value of foods consumed. This amount also is treated as nonmoney, and hence as a part of total income. Since farm family diets are often classified by both total income and value of food consumed, the prices used to impute a value to the home-produced food have a bearing on the magnitude of various relationships derived from analysis. The prices used in valuing these foods may range from farm sale to retail. Various inbetween prices may be selected. In the dietary surveys connected with the Consumer Purchases Study made during 1936–37 and Spending and Saving in Wartime during the spring of 1942, the prices used were those at the most likely place of purchase. These were somewhat less than retail prices since farm families in buying food get some of it from neighboring farms. In more recent studies a shift has been made to the use of farm sale prices. For the spring of 1942, the money value of home-produced food estimated at farm sale prices amounted to about 50 per cent of that estimated by using purchase prices.

The selection of prices to use depends in part on the purpose the data are to serve. If there is an interest in making the purchasing power per dollar of farm family income as nearly like that of the city family as possible, purchase rather than farm prices should be used to impute a value to home-produced foods. However, even when these are used, the purchasing power of dollars is still different and the consumption of such things as meat and milk by farm families is very high in relation to imputed prices. For many all-round economic analyses it is desirable to value food on the basis of the cost as seen by the family. For most foods this is the sale price which represents a measure of income foregone. To make farm-urban comparisons as to level of dietary adequacy achieved at a given level of real income, measures of relative costs of living are needed.

The importance of taking into account the prices used for imputation can be illustrated with data from the 1941 national dietary survey. At the net money income level of $1,000–$1,500, the value of total food consumed as a percentage of total income with two types of prices used for valuation is as follows:

IMPUTED PRICES	TOTAL INCOME	VALUE OF FOOD	FOOD AS A PERCENTAGE OF INCOME
Purchase	$1,783	$662	37 per cent
Farm sale[1]	1,600	479	30

[1] The value of home-produced food as reported in the U. S. Dept. of Agr. Misc. Pub. 520 was cut in two. This adjustment factor is based on a comparison of relative prices in U. S. Dept. of Agr. Misc. Pub. 550 that reports the data for a 7-day period in the spring of 1942 (42) (47).

Dietary Patterns.—The data from family dietary surveys provide a fund of in-

formation on dietary patterns. These are of quite different types. There are, for example, menu patterns, such as are commonly secured as part of the family food record, which can be analyzed to show the frequency of various food combinations. Data on the percentage of families in a given region consuming specified goods during the week of the survey also tell much about the diet patterns. In addition, statistical measures of interrelations of the foods and the nutrients in the diets are also of interest. Preliminary examination of the data from food records of nonfarm families reporting in the Consumer Purchases Study suggest that the relation of nutrients and foods in family diets as well as their interrelations are linear.

Some exploratory analysis of this type has been done through the multiple correlation of calories and selected nutrients with 11 food groups. Such an analysis, in addition to providing correlation and partial regression coefficients of the various foods and nutrients in family diets, provides a basis for developing food budgets within customary food habits. These can conform to selected levels of nutritive adequacy with or without regard to minimizing cost. Such analysis also provides a method of estimating the relative cost of food providing diets of specified nutritive quality for families of various types and among different types of communities.

FAMILY DIETARY SURVEYS IN RELATION TO NATIONAL FOOD SUPPLIES

Many uses for data from family dietary surveys have already been suggested in this chapter. An additional use is that of interpreting estimates of national food supplies and food requirements.

As one measure of food consumption, the U. S. Department of Agriculture periodically publishes estimates of yearly per capita consumption of various foods. These averages are derived from national aggregates of consumption based on statistics of production, foreign trade, inventories on hand, industrial uses, feed, seed, and estimates of losses in distribution between farm and kitchen. Calculations are made of the nutrient content of the per capita supplies available for direct human consumption. These data are especially useful for showing changes in consumption and for relating changes in the calculated nutrient content to shifts in consumption of different kinds of food or to some program such as the enrichment of flour and bread. Such an analysis covering a 37-year period was recently published (46).

Per capita averages include all the food that goes into institutions and public eating places as well as that which goes into the home, and pool the extremely good with the extremely poor in giving a single measure. The limitations of these data as a basis for judging the nutritional adequacy of national food supplies are obvious. For example, calcium is the only one of the 9 nutrients considered that during the 37-year period falls markedly below the recommended allowances of the National Research Council. However, dietary surveys of housekeeping families show a very different picture. The Consumer Purchases Study in 1935–36 indicated inequitable distribution for many foods and nutrients. The following statement briefly summarizes its findings:

"About three-fourths of the families in the United States had diets that did not meet the National Research Council's recommendations for riboflavin and about half had diets that were low in calcium, thiamine, and ascorbic acid." (47)

Over-all national averages for 1942 indicate no deficiencies. Nevertheless, from dietary surveys it is estimated that in the spring of 1942 the diets of more than half of the families failed to meet the recommended allowances for riboflavin, although the proportion correspondingly low in calcium had been reduced to less than a third and the proportion low in thiamine, to a fourth (46).

National per capita averages nevertheless have value as indicators of relative adequacy. It seems highly probable that as national per capita averages of various nutrients change, all or almost all population groups are somewhat affected even though not equally. The per capita national averages are thus useful in indicating trends. If the distribution among population groups within various countries were about the same, and if the methods of calculation were comparable, national per capita averages would also be useful in indicating relative adequacy of diets among countries.

Figures on national per capita consumption combined with estimates of the quantities of different kinds of food needed to bring diets of poorly fed population groups up to some one or more recognized levels of nutritional adequacy also enable the nutritionist and food economist to indicate in quantitative terms the increases in consumption (and production) that might well contribute to improved national well-being. Such data, as well as trends in consumption and analyses of market demand under varying assumptions of incomes and prices, are basic in developing requirements for domestic production of and international trade in agricultural products.

BIBLIOGRAPHY

1. Atwater, W. O.: Principles of Nutrition and Nutritive Value of Foods. U. S. Dept. of Agriculture Farmers' Bull. No. 142, 1902.
2. Bigwood, E. J.: Guiding Principles for Studies of the Nutrition of Populations. Geneva. League of Nations Health Organization, Technical Commission on Nutrition, 1939.
3. Darby, W. J.: The Influence of Some Recent Studies on the Interpretation of the Findings of Nutrition Surveys. J. Am. Dietetic Assoc., *23:* 204–210, 1947.
4. Darby, W. J., Hahn, P. F., Kaser, M. M., Steinkamp, R. C., Densen, P. M., and Cook, M. B.: The Absorption of Radioactive Iron by Children 7–10 Years of Age. J. Nutrition, *33:* 107–119, 1947.
5. Putnam, P., Milam, D. F., Anderson, R. K., Darby, W. J., and Mead, P. A.: The Statistical Association Between the Diet Record of Ascorbic Acid Intake and the Blood Content of the Vitamin in Surveyed Populations. In press.
6. Kling, W.: Food Waste. J. Farm Economics, *25:* 856–857, 1943.
7. Stiebeling, H. K., Monroe, D., Phipard, E. F., Adelson, S. F., and Clark, F.: Family Food Consumption and Dietary Levels, Urban and Village Series. U. S. Dept. of Agriculture Misc. Pub. 452, 1941.
8. Bureau of Human Nutrition and Home Economics, U. S. Dept. of Agriculture. Unpublished data.
9. U. S. Bureau of Labor Statistics: Family Spending and Saving in Wartime. U. S. Dept. of Labor Bull. 822, 1945.
10. Stiebeling, H. K. and Phipard, E. F.: Diets of Families of Employed Wage Earners and Clerical Workers in Cities. U. S. Dept. of Agriculture Circular 507, 1939.
11. U. S. Bureau of Labor Statistics: Family Expenditures in Selected Cities, 1935–36. Vol. II, Food. U. S. Dept. of Labor Bull. 648, 1940.
12. Kaser, M. M., Steinkamp, R. C., Robinson, W. D., Patton, E. W., and Youmans, J. B.:

A Comparison of the Calculated and Determined Calorie and Vitamin Contents of Mixed Diets. Am. J. Hyg., *46:* 297–325, 1947.

13. Milam, D. F. and Darby, W. J.: The Average Diet of a Southern County and Its Effects on Nutritional Status. South. Med. J., *38:* 117–125, 1945.
14. Milam, D. F.: A Nutrition Survey of a Small North Carolina Community. Am. J. Pub. Health, *32:* 406–412, 1942.
15. Pelc, H. and Podzimkova-Rieglova: L'Alimentation d'une Famille Agricole Slovaque d'Après sa Consommation Alimentaire Relevée Pendant une Année. Les Trouveaux de l'Institut d'Hygiène Publique de l'Etat Ichécoslovaque, No. 4. Prague. October 1934.
16. Children's Fund of Michigan: Proceedings of Conference on Methods of Evaluating Nutritional Status of Mothers, Infants and Children. Detroit. February 1947. (Mimeo.)
17. Patterson, J. M. and McHenry, E. W.: Errors in the Calculation of the Nutritive Value of Food Intake. I. Comparison of Calculated and Determined Amounts of Calories, Protein and Fat. Canad. Pub. Health J., *32:* 362–365, 1941.
18. Hummel, F. C., Shepherd, M. L., Galbraith, H., Williams, H. H., and Macy, I. G.: Chemical Composition of Twenty-Two Common Foods and Comparison of Analytical with Calculated Values of Diets. J. Nutrition, *24:* 41–56, 1942.
19. Widdowson, E. M. and McCance, R. A.: Food Tables: Their Scope and Limitations. Lancet, *1:* 230–232, 1943.
20. Semmons, C. M. and McHenry, E. W.: Errors in the Calculation of the Nutritive Value of Food Intake. IV. Comparison of Calculated and Determined Amounts of Calcium. Canad. J. Pub. Health, *35:* 286–290, 1944.
21. Gutman, A. B. and Low, M.: On the Approximation of the Calculated to Determined Calcium Content of Human Dietaries. J. Nutrition, *18:* 257–263, 1939.
22. Kaucher, M., Moyer, E. Z., Harrison, A. P., Thomas, R. U., Rutledge, M. M., Lamec, W., and Beach, E. F.: Nutritional Status of Children. VII. Hemoglobin. J. Am. Dietetic Assoc., *24:* 496–502, 1948.
23. Young, C. M. and McHenry, E. W.: Errors in the Calculation of the Nutritive Value of Food Intake. III. Comparison of Calculated and Determined Amounts of Iron. Canad. J. Pub. Health, *34:* 367–370, 1943.
24. Young, C. M. and McHenry, E. W.: Errors in the Calculation of the Nutritive Value of Food Intake. II. Comparison of Calculated and Determined Amounts of Ascorbic Acid. Canad. J. Pub. Health, *33:* 224–228, 1942.
25. Bureau of Human Nutrition and Home Economics in Cooperation with National Research Council: Tables of Food Composition in Terms of Eleven Nutrients. U. S. Dept. of Agriculture Misc. Pub. 572, 1945.
26. Bowes, A. de P. and Church, C. F.: Food Values of Portions Commonly Used. 5th Ed. Philadelphia. Philadelphia Child Health Society, 1944.
27. Taylor, C. M.: Food Values in Shares and Weights. New York. The Macmillan Company, 1942.
28. Bradley, A. V.: Tables of Food Values. Rev. Ed. Peoria, Ill. Manual Arts Press, 1942.
29. Sherman, H. C.: Chemistry of Food and Nutrition. 7th Ed. New York. The Macmillan Company, 1946.
30. Food and Agriculture Organization of the United Nations: Energy-Yielding Components of Food and Computation of Calorie Values. Washington, D. C., May, 1947.
31. Berryman, G. H. and Chatfield, C.: Short Method of Calculating the Nutritive Value of Diets. J. Nutrition, *25:* 23–37, 1943.
32. Donelson, E. G. and Leichsenring, J. M.: A Short Method for Dietary Analysis. J. Am. Dietetic Assoc., *18:* 429–434, 1942.
33. Donelson, E. G. and Leichsenring, J. M.: Food Composition Tables for Short Method of Dietary Analysis (Revised). J. Am. Dietetic Assoc., *21:* 440–442, 1945.
34. Steinkamp, R. C., Robinson, W. D., and Kaser, M. M.: Adaptation of Short Method of Calculating the Nutritive Content of Diets in Rural Areas in Middle Tennessee. J. Am. Dietetic Assoc., *21:* 522–526, 1945.

35. Hawley, Edith: A Short Method of Calculating Energy, Protein, Calcium, Phosphorus and Iron in the Diet. U. S. Dept. of Agriculture Tech. Bull. 105, 1929.
36. League of Nations: The Problem of Nutrition. II. Report on the Physiological Basis of Nutrition. Ser. League of Nations Publication II-B-4, Geneva, 1936.
37. Leitch, I.: The Evolution of Dietary Standards. Nutr. Abst. & Rev., *11:* 509–521, 1942.
38. Food and Nutrition Board: Recommended Dietary Allowances. Nat. Res. Coun. Reprint and Circular Series No. 115, January 1943.
39. Food and Nutrition Board: Recommended Dietary Allowances, Revised 1945. Nat. Res. Coun. Reprint and Circular Series No. 122, August 1945.
40. Food and Nutrition Board: Recommended Dietary Allowances, Revised 1948. Nat. Res. Coun. Reprint and Circular Series No. 129, October 1948.
41. McHenry, E. W.: Nutrition in Toronto, Canada. Canad. J. Pub. Health, *30:* 4–13, 1939.
42. Bureau of Human Nutrition and Home Economics: Rural Family Saving and Spending in Wartime. U. S. Dept. of Agriculture Misc. Pub. 520, 1943.
43. Reid, M. G.: Food for People. New York. John Wiley and Sons, Inc. 1943.
44. United States Congress. Joint Committee on International Revenue Taxation: The Taxation of Pensions and Annuities. Washington. 79th Congress, 2nd Session, H.R. 2948. 1946. p. 56, illus.
45. Brady, D. S., Monroe, D., Phelps, E., and Rainboth, E. D.: Family Income and Expenditures, Five Regions. Part 2. Family Expenditures, Urban and Village Series. U. S. Dept. of Agriculture Misc. Pub. 396, 1940.
46. Clark, F., Friend, B., and Burke, M. C.: Nutritive Value of the Per Capita Food Supply, 1940–45. U. S. Dept. of Agriculture Misc. Pub. 616, 1947.
47. Bureau of Human Nutrition and Home Economics: Family Food Consumption in the United States, Spring 1942. U. S. Dept. of Agriculture Misc. Pub. 550, 1944.

APPENDIX. SAMPLES OF SCHEDULES

I. FORMS FOR STUDYING FOOD INTAKE OF INDIVIDUALS

A. SCHEDULE USED FOR OBTAINING DIET RECORDS OF STUDENTS USED BY THE MILBANK MEMORIAL FUND, NEW YORK CITY.

N.S.9 PUPIL DIET RECORD Date_____ Taken by_____ Name_____ Record No._____

	BREAKFAST		NOON MEAL		NIGHT MEAL	
	Description of Food	Amount	Description of Food	Amount	Description of Food	Amount
YESTERDAY						
DAY BEFORE YESTERDAY						

BETWEEN MEALS

Yesterday

Food_____ Am't

Food_____ Am't

Food_____ Am't

FOOD HABITS

Yesterday's lunch: Eaten at home____ Carried____ B'ght.____ At school____ Free____

Previous day's " : Eaten at home____ Carried____ B'ght.____ At school____ Free____

Do you usually eat about the same breakfast?_____

If not, explain_____

Do you usually eat about the same amount of food, as in the past 2 days?_____

Do you drink milk?_____ No. of glasses per week_____ Eggs per week_____

Kinds of fresh fruit eaten in past 7 days:_____

Vegetables in past 7 days:_____

Vitamin preparation: Kind_____ Brand_____ Am't._____

-33-

ACTIVITIES

Hour arose this A.M._____ Yesterday_____ Hr. to bed last night_____ Previous_____

School exercise periods: Yest._____ Prev._____

Outdoors: Yest._____ Prev._____

Work or chores: Yest._____ Prev._____

Reading or studying: Yest._____ Prev._____

Indoors: Movie, etc. Yest._____ Prev._____

Other:_____

USUAL ACTIVITIES

School clubs_____

Other clubs_____

Athletics_____

Dancing_____

Movies_____

Other_____

Late

Food_____ Am't._____

Vitamin Preparation:

Kind_____

Brand_____

Am't._____

B. SCHEDULES FOR OBTAINING DIET RECORDS OF PREGNANT WOMEN, VANDERBILT UNIVERSITY,
SCHOOL OF MEDICINE, NASHVILLE, TENNESSEE

DAY OF WEEK

DATE

MEAL	KIND OF FOOD	AMOUNT
BREAKFAST		
Between Breakfast and Dinner		
DINNER		
Between Dinner and Supper		
SUPPER		
Between Supper and Bedtime		

DIET RECORD DURING PREGNANCY

NAME _____ HISTORY NUMBER _____ W.P. _____

DATE _____ TO _____ TRIMESTER _____

Measuring Directions

Record all food eaten and all drinks except water. Judge the amounts as well as you can and fill in this record after each meal.

I. Bread - Tell number of pieces, kind and size. Such as: 2 small buttermilk biscuits, or, 1 piece of cornbread (with egg) 2 inches square and 1 inch thick.

II. Butter or Oleomargarine - Measure by level teaspoons or tablespoons.

III. Cereals - Judge by cups. Such as: 1 cup cornflakes or 1/3 cup of cooked oatmeal. Give amounts of sugar, milk, or cream used.

IV. Candy - Kind, size, a

V. Desserts - Judge amou
cake has icing. Giv

VI. Drinks - State whethe
drink, give name of

VII. Fruits - Tell size an
canned peaches. If

VIII. Meats - Tell kind, how it is cooked, and size of piece eaten. Tell amount of gravy eaten.

IX. Sandwiches - Tell kind of bread and what is in the sandwhich.

X. Soups and Stews - Give amounts and name ingredients.

XI. Vegetables - Tell kind and amount, judged by tablespoons or cupfuls after cooking, unless served raw. Give amounts of raw vegetables eaten and kind and amount of dressing used.

Individual instructions are given by a nutritionist before record is kept. Upon completion the record is discussed with the subject and additional information on recipes, sizes of servings, etc. is obtained.

Supplements:

C. SCHEDULES FOR OBTAINING DIET HISTORY AND DIET RECORD OF PREGNANT WOMEN, HARVARD SCHOOL OF PUBLIC HEALTH, BOSTON, MASS.

PRENATAL NUTRITION HISTORY

✸ Form Prepared by Department of Maternal and Child Health, Harvard School of Public Health

Name_____ Study Number_____ Hospital Number_____ Date_____

Average Intake (amount and frequency)	Prev. to Preg.	First Trimester	Second Trimester	Third Trimester
Milk (all forms)				
Meat, Fish, Liver, Poultry				
Prepared Meats, etc.				
Eggs				
Fruit: Citrus, Tomatoes, etc.				
Fruit: Dried				
Fruit: Others				
Vegetables: Dk.Gr.Leafy or Deep Yellow				
Vegetables: Legumes				
Vegetables: Potato				
Vegetables: Others –				
Vegetables: Others –				
Cereals: Whole Grain				
Cereals: White				
Bread, Whole Grain o				
Macaroni, Rice, etc.				
Crackers				
Cookies				
Butter or Oleo				
Other Fats				
Nuts and Peanut Butte				
Puddings				
Pie				
Cake, Doughnuts, etc.				
Ice Cream				
Candy and Other Sweet				
Jam, Jelly, etc.				
Sugar				
Sirup				
Molasses				
Salt				
Soup				
Beverages: Tea and Co				
Beverages: Cocoa or C				
Beverages: Soft Drink				
Beverages: Beer, Wine				

Name_____ Hospital Number_____
Study Number_____ Date_____

Health Habits and Other Factors Relating to Nutrition

	Previous to Pregnancy	First Trimester	Second Trimester	Third Trimester
Meals/Day				
Appetite				
Food Dislikes				
Frequency Nausea				
Frequency Vomiting				
Vitamin Concentrates				
Other Nut. Concentrates				
Bowels: Regularity				
Bowels: Laxative (Kind and Freq.)				
Sleep: Hours				
Sleep: Sound or Disturbed				
Day Rest: Hours				
Day Rest: Sleep				
Outdoor Exercise				
Work: Kind				
Work: Hours				
Cigarettes No./Day				
No. Persons Living in Family				
Income				
Number of Rooms				
Other Factors				

Food Intake (Pattern of eating previous to pregnancy and usual variations)

Breakfast __ a.m.		Noon Meal __ p.m.		Evening Meal __ p.m.	
	Am't		Am't		Am't

✸ Form used in cross checking information obtained by interview regarding food intake. Later, the amount of each food or food group which is most representative of the subjects average intake is used for computation of calories, proteins, 3 minerals, and 5 vitamins. Diet is then evaluated and rated.

Name_____ Weight _____ Date_____

Food Intake (Pattern of eating during_____)

Breakfast __a.m.		Noon Meal __p.m.		Evening Meal __p.m.	
	Am't		Am't		Am't

Comments:

I. C. (continued)

HARVARD SCHOOL OF PUBLIC HEALTH
HEALTH CONFERENCE
55 SHATTUCK STREET, BOSTON, MASSACHUSETTS

One Complete Day's Record of Food Eaten

Directions:

Orange juice or fruit: State number of oranges and size used.

Other fruit: State kind, number or size of serving (1 small sauce dish = ½ measuring cup, 4 rounding tbsps.* = ½ cup, 16 level tbsps. = 1 cup).

Cereal: State amount as rounding tbsps. or in terms of measuring cup.

Bread: State number of slices, and if purchased as sliced bread. If not, state thickness as ¼ or ½ inch or whatever it is.

Butter: Record as level tsps. (1 pat = 1 level tsp.†).

Egg: Check as to whether whole egg or yolk only.

Bacon: Number of slices—indicate whether long (full length) slices or ½ slices.

Milk: Amount on cereal—state in terms of measuring cup. If top milk or cream used, cross out milk. State cream light, medium, or heavy. Cup refers to measuring cup. *1 ordinary drinking glass = ¼ cup.* 1 tall glass (iced tea glass) = 1¼ cup. Where it states milk or cream, cross out one not used.

Sugar: Give as level tsps.

Other foods: Record as accurately as possible in ordinary household measures any foods eaten not listed.

Meat or Fish:
1 small serving meat or fish = 1 oz. = 2 tbsps.
1 average serving meat or fish = 3 oz.
1 large serving meat or fish = 4 oz.

Vegetables: Record in rounding tbsps.
(1 ordinary small saucer of vegetables = ½ cup = 4 rounding tbsps.)

Dessert:
Average serving = ½ cup.
Milk or sauce, etc., added should be recorded and amount stated.

* Tablespoon = tbsp. † Teaspoon = tsp.

Name ..... **Date** .....

Address .....

Read directions carefully before filling out the following:

Breakfast: **Time** ..... a.m.

Orange ..... Amount. Other fruit ..... Amount .....

Cereal—Kind ..... Amount .....

Bread—Kind ..... {No. slices ..... / Thickness ..... inch} Toasted {Yes / No}

Butter—Amount ..... tsps.

Egg ..... No. whole egg or yolk. How cooked .....

Bacon ..... No. of slices. Sugar on cereal ..... tsps.

Milk ..... Amount on cereal. Milk to drink ..... cups

Cocoa ..... cups. Other beverage ..... cups

Is cocoa made with milk? ..... If not, what part milk? .....

Sugar in cocoa or other beverage ..... tsps.

Milk or cream added to cocoa or other beverage ..... tbsps.

Other foods eaten ..... Amounts .....

..... Amounts .....

Between Breakfast and Dinner

Foods eaten ..... Amounts .....

..... Amounts .....

..... Amounts .....

(Include ice cream, candy, sodas, etc.)

Time ..... a.m. Regular ..... Irregular .....

Dinner (Midday Meal) ..... **Hr.**

Soup ..... Kind. Amount .....

Meat, egg, fish or substitute ..... Kind. Amount .....

Potato—No. and size ..... How cooked .....

Skin eaten .....

Cooked vegetables ..... Kind. Size of serv. .....

..... Kind. Size of serv. .....

Raw vegetables ..... Kind. Size of serv. .....

..... Kind. Size of serv. .....

Bread: Kind ..... {No. slices ..... / Thickness ..... inch}

Amount of butter used on bread, potato, vegetables ..... tsps.

Amount of salad dressing and kind ..... tsps.

Amount of gravy ..... tbsps.

Milk: Amount ..... cups Other beverage ..... cups

Sugar in beverage ..... tsps. Cream or milk ..... tbsps.

Dessert: Kind ..... Size of serving .....

Other foods eaten ..... Amounts .....

..... Amounts .....

..... Amounts .....

Between Dinner and Supper

Foods eaten ..... Amounts .....

..... Amounts .....

..... Amounts .....

(Include ice cream, candy, sodas, etc.)

Time ..... p.m. Regular ..... Irregular .....

Supper (Evening Meal): **Time** ..... p.m.

Main Dish: Kind ..... Amount .....

Potato: No. and size ..... How cooked .....

Skin eaten .....

Vegetables: Cooked: Kind ..... Size of serv. .....

Raw: Kind ..... Size of serv. .....

Bread: Kind ..... {No. slices ..... / Thickness ..... inch}

Amount of butter used on bread, potato, vegetables, etc. ..... tsps.

Salad dressing: Kind ..... Amount .....

Gravy ..... tbsps.

Milk: Amount ..... cups Other beverage ..... cups

Sugar in beverage ..... tsps. Cream or milk ..... tbsps.

Dessert: Kind ..... Size serving .....

Other foods eaten ..... Amounts .....

..... Amounts .....

Between Supper and Bedtime

Foods eaten ..... Amount .....

..... Amount .....

..... Amount .....

(Include ice cream, candy, sodas, etc.)

Time ..... p.m. Regular ..... Irregular .....

Cod Liver Oil ..... tsps. No. times daily .....

or

Substitute ..... drops

Water: No. of glasses daily .....

Appetite, less than usual ..... usual .....

more than usual .....

Sickness or indisposition, specify .....

Remarks:

II. FORMS FOR STUDYING THE FOOD INTAKE OF FAMILIES

A. EXCERPTS OF A FOOD RECORD SCHEDULE, BUR. OF HUMAN NUTRITION AND HOME ECONOMICS, U.S. DEPT. OF AGRICULTURE, WASHINGTON, D.C

A. Inventory of Food on Hand and Record of Food Brought into Home During Week

Food on hand.--The agent who visits your home will help you record what is on hand at the beginning of the week and again at the end. All staple foods stored in cabinet, cupboard, or pantry, or kept on dining room table or buffet and more perishable foods held in refrigerator, cold box, or cellar should be included. Any large supply of staple foods as potatoes, flour, home canned food, smoked meats, or frozen food in a storeroom, cellar or freezer locker separate from the kitchen, need not be entered on the inventory. Instead, supplies for current use can be entered when they are brought from storage into the kitchen.

Food brought in during the week.--List all foods brought into the kitchen before you put them away or use them. Include all food whether--Paid for or charged,
Carried or delivered,
Bought or from garden or storage (not inventory),
A gift or payment in food.

Before listing the food for a day, on the next free line in column 1, enter the day and date, as--.st day, October 14. If for any day no food is brought into the house, enter the day and date in column 1 and write "none" in column 2.

Inventory dates: Date of beginning inventory _____ after _____ meal
Date of closing inventory _____ after _____ meal

Food	Fresh, frozen, canned, dried, cured, ready-cooked	Bought, home-produced, other	Food on hand at beginning and food brought in day by day			Closing inventory		
			Number of units	Unit (Lb., qt.)	Price and unit of bought food	Number of units	Unit (Lb., qt.)	Price and unit of bought food
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1 Fat in salvage can								
2					$			$ for

B. Recipe Sheet

Enter a recipe for each food mixture prepared at home that is--(1) on hand at time of beginning inventory, (2) on hand at time of closing inventory, or (3) eaten during the week of the record by a child in the 3rd - 6th grade.

1. Recipe: (a) Name _____ (b) Dates eaten during week _____
2. For mixtures entered on either inventory, give proportion of total recipe on hand at time of: (a) Beginning inventory _____ (b) Closing inventory _____
3. For mixtures eaten by children in 3rd - 6th grades, give proportion of total recipe eaten during week by each child:
Child No. 1 _____ Child No. 2 _____ Child No. 3 _____

Foods	Fresh, frozen, canned, dried, cured, ready-cooked	Bought, home-produced, other	Quantity		Food mixtures on inventories
			Number of units	Unit (Pt., cup, tbsp., tsp.)	Price and unit of bought food
List all foods used in recipe except seasonings, spices, flavorings; exclude water					
(1)	(2)	(3)	(4)	(5)	(6)
					$ for

II. A. (continued)

C. Daily Menu from Family Food Supplies Day _____ Date _____

Menu. Enter all foods and mixed dishes made from family food supplies that were eaten at meals or between meals by any member of the household or guests (1)	Quantity in household measure of each food eaten by children in 3rd - 6th grade		
	Child No. ___ (2)	Child No. ___ (3)	Child No. ___ (4)
BREAKFAST			
NOON MEAL			
EVENING MEAL			
PACKED LUNCHES			
BETWEEN-MEAL S			

(8) Enter kind help (to b garbage; a

D. Use of Cooking Water

1 a. Do you use the water in which any vegetables are cooked? Yes ☐ No ☐

b. If Yes, which vegetables?

_____

_____

_____

E. Identifying Information

1 School: Col.St. East Side
2 Assignment no. _____
3 Agent _____
4 State _____
5 City _____
6 Reviewer _____
7 Dates covered _____

DO NOT FILL

8 _____
9 _____
10 _____
11 _____
12 _____

F. Daily Record of Persons Fed from Family Food Supplies

The agent who visits your home will help you fill in this page and enter the number of meals each person has from family food supplies day by day. Remember to tell the agent about packed lunches to be eaten at work, school, or picnics, and refreshments served to guests.

(1) Persons (Give relation to head of family)	(2) Age	(3) Sex	(4) Wt.	(5) Hgt.	(6) a. Adults--Activity code b. Children--Name of school	(7) Check meals from family food supplies: 1st day	2nd day	3rd day	4th day	5th day	6th day	7th day	8th day
						1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
1													
2													
3													
4													
5													
6													
12													
Total													

G. Record of Food Eaten Away from Home by Members of Family

Tell the agent, day by day, about meals eaten away from home by family members. Do not include meals carried from home food supplies. Also report cost of meals and snacks away from home.

Meals, supplements to meals, snacks	1st day	2nd day	3rd day	4th day	5th day	6th day	7th day	8th day
1 Number of meals: At work.....								
2 At school.....								
3 Other meals out.....								
4 Total (1-3): All.....								
5 Purchased.....								
6 Expense for purchased food: Meals (in item 5)	$	$	$	$	$	$	$	$
7 Supplements.....								
8 Between-meal soft drinks, candy, etc.....								
9 Alcoholic drinks (at bar, etc.).....								
10 Total (6-9).....	$	$	$	$	$	$	$	$

B. EXCERPTS OF A FOOD LIST SCHEDULE, BUR. OF HUMAN NUTRITION AND HOME ECONOMICS. U.S. DEPT. OF AGRICULTURE, WASHINGTON, D.C.

FOOD USED (Contd.) -2-

Food (a)	Fresh frozen canned dried cured ready-cooked (b)	Quantity used: Number of units (c)	Unit: Qt. lb. doz. cup etc. (d)	Code: B MP O (e)	Bought food: Price and unit (f)	DO NOT FILL: Codes: Source (g)	Group (h)	Food (i)	Quantity of food in pounds (j)	Expense for bought food (k)
FATS, OILS										
12. Butter										
13. Margarine										
14. Lard										
21. Beef: Steak, round: Bone in__ boned__										
22. Steak, other: Bone in__ boned__										
23. Roast, rib: Bone in__ boned__										
24. Roast, other: Bone in__ boned__										
25. Boiling, stewing, soup: Bone in__ boned__										
26. Corned beef__ chipped beef__										
27. Ground										
28. Veal: Roast: Bone in__ boned__										
29. Cutlets, chops: Bone in__ boned__										
46. Fish: Salmon__ tuna fish__ sardines__ mackerel__ herring__ Live__ dress__ dressed__ steak sliced__ fillet__										
47. Other fish__ Live__ dress__ dressed__ steak sliced__ fillet__										
48. Shellfish: Clams__ crabs__ lobster__ oysters__ scallops__ shrimp__ clam juice__ other__ In shell__ shelled__										
49. Mixtures, chiefly meat, poultry, fish: Beans with franks__ chicken noodle dinner__ chicken a la king__ chili con carne__ codfish cakes__ corned beef hash__ deviled crab__ meat stew__ ravioli__ spaghetti with meat balls__ tamales__ plate meal__ other__										
67. Spinach: Trimmed__ not trimmed__										
68. Turnip greens: With turnips__ no turnips__ Trimmed__ not trimmed__										
69. Beet tops: With beets__ no beets__ Brussel sprouts__ chard__ dandelion__ poke__ other greens__ Trimmed__ not trimmed__										
70. Asparagus: Green__ white__ Whole with butt end__ tips only__										
71. Beans, lima and butter (green): In pod__ shelled__										
72. Beans, snap: Green__ yellow__										
73. Soybeans (green): In pod__ shelled__										
74. Broccoli: Trimmed__ not trimmed__										
75. Cabbage: Green__ white__ red__ Chinese__										
76. Lettuce: Headed__ leaf__										
140. Corn meal: White: Whole ground__ degerminated__										
141. Yellow: Whole ground__ degerminated__										
142. Grits: Whole ground__ degerminated__										
143. Hominy (big): Dry__ ready cooked__										
144. Corn: Popping__ popped__										
145. Rice: White__ converted__ brown__										
146. Rolled oats, oatmeal										
147. Farina__ wheat cereal__ barley__ baby cereal__										

D. FOOD NOT EATEN BY HOUSEHOLD MEMBERS that was included in the report just given

1. Fat:

	Quantity: No. units	Unit
a. Fat in the drippings can:		
(1) How much fat was on hand? (a) At beginning of week		
(b) At end of week		
(2) How much fat was sold to the butcher during week?		
b. Fat not in the drippings can:		
(1) How much salt pork cooked with beans, greens and other vegetables was left not eaten on plates, serving dishes, and cooking utensils during week?		
(2) How much other fat meat and drippings was drained down the sink, lost through spoilage, given away, and used for soap during week? (a) Fat meat		
(b) Drippings		

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H. HOUSEHOLD COMPOSITION DURING LAST 7 DAYS AND 1947, NUMBER OF MEALS EATEN AT HOME AND EXPENSE FOR FOOD EATEN AWAY FROM HOME

Family members by relationship to head and other persons in household (1)	Sex (2)	Age (3)	Wt. (4)	Ht. (5)	Adults only activity code (6)	During last 7 days: Number of meals: Obtained from family food supplies (7)	Received as gift or pay (8)	Bought and eaten away from home (9)	Expense for food away from home: Meals (10)	Between meal food and drink; supplements to carried meals (11)
At time of interview:										
1. Family members:									$	$
2.										
7.										
8.										
9.										
10. Hired help, guests, etc:										
Others:										
11. Family members:			xx	xx	xx					
12.			xx	xx	xx					
13.			xx	xx	xx					
14. Hired help, guests, etc:			xx	xx	xx					
15. Total (1-14)	xx	xx	xx	xx	xx					
Roomers and boarders eating meals during last 7 days										
16.					xx					
17.					xx					
18.					xx					
19. Total (15-18)	xx	xx	xx	xx	xx					

I. INCOME: (/) Last week__ last month__

Family member no., Sec. I (use separate line for each job) (1)	Type of: Occupation (mechanic sales clerk, doctor) (2)	Place employed (steel mill, bank, shoe store) (3)
1.		
2.		
3.		
8.		
9.		
10. Total (1-9)	xx	xx

Section III

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INTRODUCTION

As information has accumulated concerning the chemical structure and function of essential nutritive factors, procedures have been developed for measuring the levels of these substances in bodily tissues and fluids and for detecting metabolic abnormalities which occur when the supply of these nutrients is insufficient. Many chemical and microbiological methods have been developed which are specific, accurate, and relatively easy to perform, but interpretation of the findings obtained with these methods, with respect to the adequacy of nutrition, remains fraught with difficulty. While it is generally agreed that there are important relationships between various levels of nutrition and growth, development, and the maintenance of normal health, quantitative definition of these relationships has not been accomplished. Data concerning human nutritional requirements are insufficient, knowledge of what constitutes optimal growth is lacking, and neither standards nor methods of precision for measuring normal health are available. Although considerable evidence indicates that there is a difference between the quantity of a nutrient which will protect against deficiency disease and illness, and the quantity necessary for the most efficient functioning of the body and the best possible health, knowledge of these amounts is largely unknown. Physiological and biochemical tests have not been sufficiently studied at various levels of nutrition for precise interpretation, nor have the concepts of adequate nutrition, potential deficiency, or optimal nutrition been clearly delineated. Unfortunately, these terms have been widely used in evaluating dietary, clinical, and biochemical findings in the appraisal of the nutritional status. This has led to differences of opinion as to the value of certain procedures and even to the condemnation of certain methods which, if properly applied and interpreted, might prove accurate and useful.

It is generally agreed that deficiency disease develops gradually and that several stages or degrees of deficiency may be recognized. At first there is a depletion of bodily stores of a nutrient, accompanied or followed by changes in the excretion of this substance or its metabolites and by diminution in the concentration of the nutrient in free or combined form in the blood. As deficiency continues there is impairment of function, and finally anatomical changes occur in the tissues and clinical signs of deficiency make their appearance.

Dann and Darby (1) have suggested that in the appraisal of nutritional status the following zones of nutriture might be recognized: (1) saturation ("the state in which the body is incapable of increasing its content of certain nutrients"); (2) unsaturation without functional impairment; (3) potential deficiency disease (decreased reserve functional capacity); (4) latent deficiency disease (vague symptoms responding to specific therapy); and (5) clinically manifest deficiency disease.

Chemical tests have been devised which may be applied in each of these zones of nutriture although in many instances they are few in number. Tests are available which will measure the degree of saturation of the body with a given nutrient (particularly of a vitamin) and there are numerous procedures by which excretion of a nutritive factor or its metabolites, or the level in the blood or bodily tissues may be determined. A few tests have been devised for measuring abnormalities in the function of essential nutrients. The reliability of available tests in the diagnosis of potential or latent deficiency disease has been seriously questioned. For evaluation in this borderline zone, new procedures must be developed and carefully controlled experiments conducted with present methods in an endeavor to correlate clinical, physiological, and biochemical findings. Nevertheless, much can be learned by the proper application of current knowledge in the appraisal of nutritional status.

The concentration of many essential nutrients in the blood, urine, or other bodily fluids reflects in a general way the recent dietary intake of these substances. However, concentration does not always bear a linear relationship to intake and many disturbing factors may influence findings in individual cases, particularly in the presence of illness. "Saturation", "load", or "tolerance" tests will determine the degree of saturation or depletion of the tissues with a given vitamin. The term saturation is an unfortunate one and should be used to denote maximal tissue concentration rather than optimal nutrition. In this sense, saturation suggests at least adequate nutrition and is a useful concept. Unsaturation may be compatible with undisturbed function, although an inability to withstand long periods of deprivation may be associated with this state. The question which must be answered is: at what tissue concentration does depletion become dangerous? As Johnson (2) has indicated, unsaturation is an indispensable and primary requisite in the diagnosis of deficiency, but corroborative evidence is necessary to complete the diagnosis. A given level of unsaturation may be considered indicative of deficiency only if clinical signs can be shown to occur at this level or if a brief period of deprivation will lead to manifest deficiency disease under controlled experimental conditions. Further difficulties in interpretation may be encountered in subjects, previously unsaturated, who have recently had access to nutrients sufficient to raise tissue concentration without restoring function or reversing pathologic changes.

Determination of the optimal level of a nutrient in the body will require long-term experiments. Repeated surveys of population groups who have been consuming diets extremely low in certain essential substances for many years may be of assistance in answering this problem, as well as the question of whether adaptation occurs to diminished nutrient supply.

The choice of chemical procedures for use in nutritional studies is dependent on the problems to be investigated. As Bessey and Lowry (3) have emphasized, reliable results will be obtained only if the strong and weak points of various methods are recognized and good judgment is used as to the circumstances under which tests are applied. In surveys, chemical procedures should be technically simple and inexpensive and should permit large numbers of samples to be run in a short period of time. Small specimens which may be procured with a minimum of patient inconvenience are desirable. Specificity and reliability are essential and, while accuracy should not be sacrificed, somewhat larger errors are permissible in methods applied to mass examination than in those used in testing individuals. In the interpretation of data, it should be appreciated that a single value does not represent normalcy but that there is a range of values for each physiological variant (4). Since these ranges have not been clearly defined for most of the essential nutrients, actual data obtained should be reported, preferably in the form of distribution curves. This will assist in establishing standards of normalcy and permit reevaluation in the future if and when new knowledge makes this desirable.

Micromethods such as those devised by Bessey and Lowry (5) are particularly useful in large-scale surveys. Fingertip blood is easily procured and determinations can be carried out with great rapidity. Macromethods such as those proposed by Johnson et al. (6) for field studies make use of rugged, simple equipment and can be applied in the study of population groups. The choice will depend upon the facilities available and the experience and training of the individuals participating in the survey. Findings of equal significance may be obtained with macro- or micro-procedures. In most surveys, tests which may be applied to blood are preferable to those involving analysis of urine since blood may be obtained more readily in accurate amounts and less time is required.

Specific nutrients which have been studied in nutritional surveys with the use of biochemical methods include protein, iron, calcium, vitamin A, thiamine, riboflavin, niacin, ascorbic acid, vitamin D, and occasionally certain other substances. Each of these nutrients will be considered individually, existing methods of determination appraised, and the interpretation of findings discussed.

PROTEIN

In the evaluation of protein nutrition in population groups, the only chemical test which has been widely applied has been the determination of total serum or plasma protein, although the albumin and globulin fractions have also been measured in a few instances. In early studies, serum proteins were estimated by either the macro- or micro-Kjeldahl techniques. With the latter procedure, either titration or Nesslerization has been used in estimating total nitrogen. More recently, methods dependent on specific gravity have been devised. These have the advantage of speed

and simplicity while retaining a high degree of accuracy. The falling drop method of Barbour and Hamilton (7) or of Kagan (8), the copper sulphate method of Phillips, Van Slyke et al. (9), and the micromethod of Lowry and Hunter (10), using the Linderstrom-Lang gradient tube, are all satisfactory. Atchley (11) found excellent agreement between the falling drop and copper sulphate methods and reasonably good checks between findings with these procedures and micro-Kjeldahl determinations.

The standard procedure for determining serum albumin has been separation from globulin by salt precipitation (12) or the sodium sulphite method (13) followed by determination of nitrogen by the Kjeldahl technique. Recently Lerner and Barnum (14) have proposed a method for the estimation of serum albumin and globulin, based on determination of the ultraviolet absorption of a diluted solution of serum proteins in a spectrophotometer. Total protein is measured simultaneously by one of the rapid specific gravity methods and serum albumin calculated from the combined data. This procedure may be applicable to surveys and appears worthy of critical testing.

The normal range of total serum protein in adults has been stated to be 6 to 8 gm. per cent; for serum albumin, 4.0 to 5.5 gm. per cent (15). The level of total serum protein is not as significant as that of albumin in evaluating protein nutrition, since it is influenced by the globulin fraction which may be increased in a number of pathologic states. In a recent study of 1100 subjects, Youmans et al. (16) found that 89 per cent of those with hypoalbuminemia had a normal concentration of total serum proteins.

Hypoproteinemia occurs when the protein in the diet is severely curtailed for long periods of time and in a number of diseases, including those involving the liver, certain types of renal pathology, and many conditions associated with loss of protein from the body.

The concentration of plasma proteins may remain constant for long periods of time in the presence of dietary protein deficiency. This may be due in part to the masking effect of hemoconcentration (17). If the volume of circulating plasma is determined, protein depletion may be detected at an earlier stage. The experiments of Madden, Whipple, and associates (18) have shown that plasma protein may reflect tissue stores. Elman and coworkers (19) have calculated that a reduction of 1 gm. in the total circulating plasma albumin indicates a loss of 30 gm. of body protein. A reduction in plasma albumin concentration from 4 to 3.5 gm. per 100 cc., in a person whose plasma volume was 3500 cc., would mean a reduction in total plasma albumin of 17 gm. and a tissue loss of about 510 gm. (20). If Elman's findings are correct, hypoproteinemia indicates protein deficiency of moderately advanced degree. Slight reduction in the concentration of total serum protein, or particularly of serum albumin, is significant in persons who are ambulatory and without signs of complicating disease.

In nutrition surveys in the United States (16) (21) hypoproteinemia has been an uncommon finding. In the study of a large population group in Tennessee, the incidence of hypoproteinemia was 3 per cent, of hypoalbuminemia 9 per cent (16). There was no demonstrable correlation between the level of serum albumin and the intake of calories, total protein, or animal protein. Dietary restrictions must

FOOD TECHNOLOGICAL RESEARCH INSTI
LIBRARY

apparently be more severe than those encountered in this study before a relationship between serum levels and protein intake can be demonstrated.

In a study of protein requirements, Hegsted and coworkers (22) found that total protein, plasma albumin, and plasma globulin tended to decrease when low protein, all-vegetable diets were fed at a level low enough to produce negative nitrogen balance. Kark, Bean, and their coworkers (23) in a study of the nutrition of troops in tropical areas found that there was reasonable correlation between the average intake of protein and the concentration in the serum. Indian troops, with a lower intake than Americans or Canadians, had lower levels of serum protein. Hypoproteinemia of mild degree was found to be common in certain famine areas (24) and in concentration camps (25) in World War II. Keys and coworkers (24) found a slight decrease in the plasma protein in 34 men maintained on a European type of famine diet for 6 months. A close correlation between "hunger" edema and levels of serum protein was not observed in these studies or in similar investigations elsewhere. This is not surprising in view of the multiple factors which affect edema formation. The complete story of the pathogenesis of nutritional edema has not been elucidated.

In the light of available evidence, it seems fair to interpret a low concentration of protein in the blood, particularly of the albumin fraction, as indicative of dietary protein deficiency if disease etiologically associated with low levels of serum protein can be eliminated.

IRON AND HEMOGLOBIN

One of the most widely used methods in appraisal of nutritional status is the determination of hemoglobin in the blood. The mean level of hemoglobin and the percentage of persons with values below the accepted range of normal have been considered good indices of the general health of the population. Many adverse environmental conditions, numerous pathologic states, particularly infections and diseases associated with blood loss, and several dietary factors, are important in the production of anemia. The quantity of hemoglobin in the blood has often been used as a measure of the prevalence of iron deficiency. This is not justifiable unless improvement can be demonstrated following therapy with iron. Iron deficiency is the most common dietary factor leading to anemia, but deficiency of protein, folic acid, and other less well defined nutrients such as the "extrinsic factor", may be of etiologic importance.

There are many methods for the determination of hemoglobin, none of which is ideal. Hemoglobin may be determined by dilution of blood with water (26) to which ammonia may be added to increase the stability of oxyhemoglobin (27). Bessey and Lowry (3) developed a micromethod requiring only 10 cu. mm. of whole blood in which, following dilution, hemoglobin is measured by light absorption in the photoelectric colorimeter.

Acid hematin procedures, although widely used, are largely unsatisfactory. It is difficult to obtain an accurate standard and color is affected by non-hemoglobin substances (27). The cyanmethemoglobin method is simple and accurate but the hazard of cyanide precludes its routine use (28). The alkaline hematin and carboxyhemoglobin procedures are a little less accurate but are satisfactory for most purposes

(28). The alkaline hematin method is preferable because it estimates carboxyhemoglobin, methemoglobin, and sulfhemoglobin, in addition to active hemoglobin. Regardless of the method chosen, photoelectric instruments are preferable to the older visual colorimeters for measurement of intensity of color. All instruments should be calibrated with one of several accurate methods such as 1) determination of oxygen capacity (29), 2) estimation of the iron content of blood or erythrocytes with the titanous chloride procedure (28), 3) the pyridine hemochromogen method with crystalline hemin as a standard (27), or 4) crystalline hemin in N/10 borate buffer at pH 9.4 (30).

Determination of hemoglobin indirectly from the specific gravity of whole blood and plasma, with the copper sulphate procedure of Phillips, Van Slyke et al. (9) has been used in many recent surveys. An accuracy of ± 2 per cent is claimed for this method.

An anemia due to iron deficiency can usually be differentiated from anemia of other causation by determination of the volume of packed erythrocytes (hematocrit) and estimation of hemoglobin and the red cell count. From these data the size of the cells, or mean corpuscular volume and the mean corpuscular hemoglobin concentration can be calculated. Iron deficiency anemia is hypochromic and often microcytic. Mean corpuscular hemoglobin concentration falls below the normal of 34 ± 2 per cent, while mean corpuscular volume is often less than the normal of 87 ± 5 cu. micra. The anemia of folic acid deficiency, sprue, pernicious anemia, and possibly of protein deficiency, is macrocytic and the mean corpuscular volume is high.

Determination of the erythrocyte count with the usual counting chamber method is not feasible in surveys. Recently, however, Blum (31) has developed a photoelectric method for estimating the red cell count which may be applicable to mass studies. Hematocrit determination is relatively easy to perform. In future surveys, it should be possible to estimate mean corpuscular volume and mean corpuscular hemoglobin concentration. These data will assist in determining the etiology of anemia in a given population group. It is also suggested that blood smears should be made routinely in surveys. These can be saved and examined, when indicated, for size of cells or the presence of malaria parasites.

Another test for detecting iron deficiency is estimation of the level of serum iron. Both macro- (32a) and micromethods (32b) are available for this determination. The normal range for plasma iron is 0.05 to 0.180 mg. per cent (32b). Low serum iron is not pathognomonic of iron deficiency, however, since Wintrobe (27), Cartwright (32c), and others have observed a diminished concentration in infections, both acute and chronic.

The normal range of values for hemoglobin has not been definitely established and is variously stated according to the method used and the interpretation of the investigator. Hemoglobin should always be expressed in grams, not in per cent of normal, and standards should be based on distribution curves which are characteristic of each age and sex group. In this country, a commonly accepted standard of hemoglobin concentration in adults has been 14 ± 2 gm. per 100 cc. of blood for females, 16 ± 2 gm. for males (27). Recently, several reports of hemoglobin concentration in college

women have been published (33) (34). Wintrobe (27) has suggested certain norma values for various age groups. Macy (35) found a range of 11 to 13 gm. in a group of children judged to be in excellent health. Milam and Muench (36) have reported distribution curves for hemoglobin as found in a survey in North Carolina. These studies, and those carried out in Britain which will be mentioned subsequently, should assist in standardizing criteria of normalcy and in recognizing variations in hemoglobin which may be compatible with good health.

A high incidence of anemia has been found in surveys in the United States, particularly in children and pregnant women of the lower income group (37) (38). A survey of hemoglobin levels in 16,000 persons in Great Britain in 1943 (39) was recently reported by the Medical Research Council, Committee on Hemoglobin Surveys. The Haldane-Gowers method, a visual colorimetric procedure, was adopted because of its wide use and simplicity. Dietary restrictions during the war did not cause deterioration of hemoglobin levels when comparison was made with previous data. Lower levels were found in women aged 40 to 49 than in other age groups and were considered to reflect blood loss and perhaps mild iron deficiency. In many instances hemoglobin concentration rose following iron therapy. The incidence of anemia in women was found to increase with the number of pregnancies. A similar relationship between pregnancy and anemia was reported in a survey in Newfoundland (40).

Several English workers (41) (42) reported a decrease in anemia in Britain during the war years and ascribed this to an increase in iron intake with the use of National whole wheat flour. Hemoglobin levels have been reported to be higher in the United States than in England, on lower intakes of iron (43). This seems to have been due to differences in methods and standards used for determination of hemoglobin (44). When the Haldane standard was re-calibrated, the levels of hemoglobin in Britain were found to be closer to those in the United States.

In the famine areas of Europe during World War II, anemia was a frequent finding and in a large percentage of cases it was macrocytic with a high color index (45) (46). Burger and coworkers (47) studied this type of anemia in Holland and found that liver, iron, and vitamins were without effect but that institution of a good diet brought about improvement. Wintrobe and Cartwright (48) found a high incidence of mild or moderate anemia, of macrocytic or normocytic type, in American military personnel who had been prisoners of the Japanese. Serum iron was slightly reduced in 55 per cent of the cases studied. The etiology of nutritional anemia not attributable to iron deficiency remains obscure, but it seems likely that deficiency of folic acid plays a role and that lack of protein, "extrinsic factor", or some poorly defined substance in the vitamin B complex may be significant.

Shank (32b), using a micromethod for determination of serum iron, has reported that when the level falls below 60 mcg. per cent, the administration of iron leads to a definite rise in hemoglobin; when the concentration of serum iron is greater than 60 mcg. per cent, therapy with iron is without effect on the hemoglobin level. Waldenstrom (48b) found iron deficiency a common problem in rural populations in Sweden. In one area, 22 per cent of the women examined had values for serum iron of less than

45 mcg. per cent. Determination of serum iron should prove to be a most useful procedure in the assessment of nutritional status.

Darby and coworkers (49) have used radioactive iron in a mass study of school children in Tennessee and showed the feasibility of this procedure in surveys. In adults, the absorption of radioactive iron was greater in persons with iron deficiency than in normal subjects. In children, the uptake of iron was correlated with the estimated yearly increase of body iron during growth. There was no correlation with estimated intake, hemoglobin level, economic status, or general nutritive state.

In general, it may be stated that determination of the concentration of hemoglobin in the blood is a valuable procedure in appraising nutritional status if the method used is carefully applied, if its limitations are sufficiently appreciated, and if findings are interpreted with full realization of the variability consistent with normal health.

VITAMINS

The procedures most commonly used for evaluation of nutritional status in regard to vitamins include measurement of the level in the blood during fasting or after giving a test dose of the vitamin and determination of the urinary excretion of the water-soluble vitamins. Excretion tests have included estimation of the output in one hour during fasting and "load" tests in which excretion is measured for a period of several hours after the oral or parenteral administration of a test dose. It is obviously impractical to determine excretion for 24-hour periods in surveys. The analysis of tissues obtained by biopsy has not been widely applied, although this procedure offers possibilities which merit further investigation.

Johnson and coworkers (50) concluded from a study of normal persons on relatively constant diets that fasting specimens were preferable to load tests and that random specimens of urine should not be used. When vitamin supplements were administered to one group of subjects, it was noted that the rate of excretion before breakfast was a more reliable index of intake in the previous few weeks than were vitamin load tests. These workers also reported that blood specimens might be collected at any time during the day without seriously influencing findings. The conclusions of Johnson et al are not necessarily valid for population groups on varied and inconstant diets.

The value of vitamin load tests in determining nutritional status has been the subject of much controversy. Opinions vary in regard to mode of administration, proper dosage, time of collecting specimens, and interpretation of results. Johnson, Contreras et al. (51) accomplished mathematical formulation of tolerance tests, both intravenous and oral, and suggested that collection of urine for one hour following an intravenous dose, and during the second hour after an oral dose (the periods of maximal excretion) might yield results comparable with those obtained from collections of 4 to 10 hours respectively. However, great individual variation might be an invalidating factor. These suggestions have not as yet been subjected to critical tests.

Berryman and coworkers (52) reported a relationship between the immediately preceding dietary intake of a given vitamin and the average urinary excretion of this

nutrient during fasting, but cautioned against using the fasting urinary level alone to diagnose nutritional status. At extremes of intake there was a high correlation between the dietary level and the urinary excretion during fasting. There was no significant correlation between fasting urinary levels and the response to load tests. These authors emphasized that there was no assurance that all subjects in a group would have the same range of excretion on the same diet. Individual differences in absorption and variations in renal threshold affect results, and there is some evidence that the volume of urine excreted may be significant. In the collection of 1-hour specimens of urine, complete evacuation of the bladder is important. Lack of attention to this detail may invalidate findings. Accuracy will be greatly increased if specimens are collected over periods of 2 or 3 hours.

The repetition of load tests in normal persons at intervals of 2 to 3 weeks had no significant effect on the results of subsequent tests (fasting or load) according to Johnson and coworkers (50). These findings would probably not apply to studies of persons with deficiency disease. Any combination of thiamine, riboflavin, or ascorbic acid could be given without influencing the excretion of the other vitamins, and niacinamide had no effect on the output of these vitamins. Johnson et al. (2) concluded that oral load tests were preferable to intravenous, in spite of possible differences in absorption rate, because vitamin deficiencies due to poor absorption cannot be detected by injection, and it is difficult to maintain sterility in field studies. For the diagnosis of chemical deficiency, Johnson suggests that both a low excretion during fasting and a poor return after a test dose should be required, in view of the marked variation between individuals under similar dietary and environmental conditions. In interpreting findings, it should be remembered that in starvation tissues are being broken down and unexpectedly large amounts of certain nutrients may be excreted in the urine (53).

Sinclair (54) stated that, in his opinion, no analysis of urine in rapidly conducted surveys could provide useful information regarding the state of nutrition. This view seems unduly pessimistic. The findings of many workers suggest that the urinary excretion of water-soluble vitamins reflects bodily stores and hence is of some assistance in evaluating the nutritional status of population groups even though absolute figures to divide normal from deficiency states are lacking.

VITAMIN A

Chemical tests for the evaluation of vitamin A nutrition in surveys have been limited to determination of the concentration of vitamin A and carotene in the blood. Tests of vitamin A absorption have been used in studying the nutritional status of individuals and in investigating problems related to vitamin A metabolism but have not been applied in mass examinations. The same is true of estimation of the vitamin A content of liver tissue obtained by biopsy.

Procedures for the determination of vitamin A in blood have included a colorimetric method based on the Carr-Price reaction in which an unstable blue color is formed by the interaction of vitamin A and antimony trichloride, and an ultraviolet absorption method in which the light absorption of a solution of the vitamin is measured at 328 mu. with a spectrophotometer. Carotene has been determined by the solvent

partition method and by the chromatographic technique. Chemical methods involving the Carr-Price reaction have been described by Kimble (55), Dann and Evelyn (56), Clausen and McCord (57), May et al. (58), and others. When these methods are used, the carotene content of the material must be simultaneously determined since it also forms a blue color with antimony trichloride. The intensity of the blue color is read at 660 mu. for vitamin A, 446 mu. for carotene, and the proper correction applied. Both the ultraviolet absorption procedure and the Carr-Price reaction have numerous drawbacks but are the only ones widely tested. Errors due to interfering substances can be serious. Bessey et al. (59) have described a microtechnique for the determination of vitamin A and carotene in blood which should be particularly useful in surveys. The method depends on saponification and extraction of vitamin A and carotene from 60 cu. mm. of serum, and measurement of the light absorption at 328 and 460 mu., followed by destruction of vitamin A and remeasurement at 328 mu. A detailed description of methods for determining vitamin A and carotene and a brief discussion of their application can be found in several recent publications (60) (61).

The normal range of values for vitamin A and carotene in the blood has not been completely determined. Among various groups of healthy individuals carotene has ranged from 50 to 400 mcg. per 100 cc. of blood (55, 62, 63, 64, 65). It has been suggested that the lower limit of normal be placed between 50 and 100 mcg. per cent for carotene, 40 and 75 I.U. for vitamin A (58, 59, 63, 64). In more recent studies the concentration of vitamin A has been expressed in micrograms, and Bessey (66) has suggested that the normal range is from 30 to 70 mcg. per 100 cc. of blood. Jolliffe (67) has considered 20 to 30 mcg. per cent as the lower limit of normal. In studies of hospitalized patients (68) and in a number of nutrition surveys (65) mean levels of both vitamin A and carotene in the blood have been lower than in normal healthy adults. In surveys in Tennessee and North Carolina (69) no correlation was found between vitamin A intake, plasma level, and clinical signs which were considered evidence of vitamin A deficiency. Krause and Pierce (70) found no difference in the concentration of vitamin A in the blood in children with and without folliculosis. In a survey in Newfoundland (71) where the intake of vitamin A was found to be low, the levels in the plasma were likewise low and the incidence of clinical signs atrributed to vitamin A deficiency was high.

In healthy adults Hsu (72) found the average concentration of vitamin A in the blood to be 56 I.U. per 100 cc. (range 30 to 104 I.U.); of carotene, 140 mcg. per 100 cc. (range 85 to 226 mcg.). In hospital patients without signs of vitamin A deficiency, the average value for vitamin A was 33 I.U. (range 0–132) and for carotene, 65 mcg. (range 0-197). In patients with clinical signs of vitamin A deficiency, averages were 6 I.U. for vitamin A (range 0–27) and 24 mcg. for carotene (range 0–141).

It seems apparent that there is a relationship between the amount of vitamin A and carotene in the blood and clinical evidence of vitamin A deficiency, but wide individual variations occur and a given level should be interpreted with caution. Moreover, it is well known that the concentration of vitamin A in the blood is decreased in many types of disease (73) (74). In normal experimental animals there is good correlation between vitamin A in the blood and liver reserves (73). Aron et al.

(75) have stated that levels of vitamin A and carotene in the blood are an expression of liver function. When the intake of vitamin A is reduced, blood levels decrease very slowly in adults, but in children reduction may be noted in 2 to 4 months. Yudkin (76) has pointed out that the quantity in the blood may be influenced by recent diet and may rise when signs of deficiency are still present. Aside from this, a normal level of vitamin A in the blood is not apt to occur in clinically manifest deficiency. It has been shown that supplements of vitamin A and carotene during pregnancy (77) will prevent the decrease which commonly occurs in the concentration of vitamin A in the blood.

In summary, a low level of vitamin A in the blood may mean vitamin A deficiency, decreased reserve stores, or the presence of some disease which affects vitamin A metabolism. Determination of vitamin A and carotene in the blood would appear to be more meaningful in group studies than in individual nutritional appraisal. Low levels suggest deficiency but should be correlated with other findings for definite diagnosis.

VITAMIN B COMPLEX

Chemical tests for three members of the vitamin B complex, thiamine, riboflavin, and niacin, have been extensively studied and applied to surveys. Excretion of other B vitamins such as pyridoxine, pantothenic acid, biotin, etc., have been included in certain investigations, but their importance in nutritional appraisal has not been demonstrated.

Thiamine.—The tests most frequently used in surveys in evaluating thiamine nutrition have been determination of the excretion in the urine for a one-hour period during fasting or for several hours following the administration of oral or parenteral test doses of this vitamin. Other tests have included measurement of thiamine in the blood or in tissues obtained by biopsy (78), determination of cocarboxylase in the blood (79), and estimation of blood pyruvic acid (80) (81) and of the blood lactate-pyruvate (82) (83) ratio during fasting, after glucose, and following exercise. Some of these procedures are more useful in appraising individual status than in evaluating the nutrition of population groups.

Methods for the determination of thiamine in urine have included: (1) the yeast fermentation procedure (84) which lacks specificity and gives higher values than other methods but has the advantage of measuring phosphorylated thiamine without hydrolysis (A technique for inactivating thiamine can be included); (2) a colorimetric method (85) using para-aminoacetophenone, the technique of which is laborious and which is not applicable to materials of very low thiamine content; and (3) the thiochrome method (86) which has been variously modified, has high sensitivity, and is applicable to material of low thiamine content but requires considerable time for completion. Perlzweig (87) has recently developed a modified thiochrome technique for rapid use in surveys. A disadvantage of the thiochrome technique is that urine contains non-thiamine fluorescent substances which may cause gross errors, particularly in urines of low thiamine content. In order to overcome this difficulty, Mason and Williams (88) suggested destruction of thiamine with sulfite to obtain a blank value, while Najjar and Ketron (89) measured fluorescence of a reagent blank

and an alkali-treated aliquot and applied a correction factor. Mickelsen, Condiff, and Keys (90) eliminated interfering substances by control of acidity in the final extraction stage.

The urinary excretion of thiamine has been widely studied and more is known about the output of this vitamin at various levels of intake, and about the relationship between clinical and laboratory findings, than for any other member of the vitamin B complex. The urinary excretion of thiamine appears in a general way to be linearly related to thiamine intake. Mickelsen, Caster, and Keys (91) have shown, with statistical methods, that the excretion of thiamine is highly characteristic of the individual, as well as of the intake, and that variability in data becomes more marked as thiamine intake increases. They have suggested determination of both thiamine and pyramin, a pyrimidine-like component of the thiamine molecule which is excreted in the urine, in evaluation of thiamine nutrition when the intake of thiamine is unknown. At low levels of thiamine intake, the excretion of pyramin is still determinable, whereas the excretion of thiamine itself becomes zero. There is considerable disagreement in the literature in regard to the quantitative output of thiamine on low intakes and concerning the levels of excretion which may be considered indicative of normalcy and deficiency. This is particularly true in the interpretation of findings after test doses have been administered.

The excretion of thiamine has been shown to fall rapidly when the intake of this vitamin is lowered (92, 93, 94, 95, 96, 97, 98). However, Najjar and Holt (95) reported that the excretion may be at minimal levels for several months before signs of clinical deficiency appear. Michelsen et al. (91) stated that with an intake of about .07 mg. per day the thiamine excretion approached zero. Similar findings were obtained by Berryman (52). Hulse et al. (99) suggested that the urinary excretion of thiamine reflected changes in the concentration of freely diffusible and extracellular thiamine.

The amount of thiamine excreted in a 1-hour fasting specimen has been considered by many investigators (100, 50, 97, 101) to be useful in evaluating nutritional status, correlating well with the average daily intake. The exact quantity which is indicative of deficiency has been stated to be zero by Holt (100), 0.6 mcg. by Johnson and 4 mcg. by Papageorge and Lewis (101). Variation in interpretation is dependent on the definition of deficiency of the individual investigator. Correlation between the 1-hour fasting excretion and the 24-hour excretion has been reported by Melnick and Field (102), Papageorge and Lewis (101), and others. Holt (103) considers that the fasting 1-hour excretion is less liable to fluctuation due to changes of intake than the 24-hour excretion. The degree of deficiency cannot be detected by either the 1-hour fasting or the 24-hour excretion.

There is even more disagreement in regard to the interpretation of load tests. It is agreed that in persons on controlled intakes, the excretion following the administration of a test dose decreases as the intake of thiamine is reduced. Delineation of the level which may be diagnostic of deficiency has not been accomplished. Najjar and Holt (95) have found that thiamine excretion, after administration of 1 mg. of the vitamin intravenously, drops to less than 50 mcg. in 4 hours when symptoms of thiamine deficiency appear. Williams and Mason (93) (94) stated that an excretion

of less than 100 mcg. with this test indicated moderate deficiency, less than 50 mcg., severe deficiency. Excretions of this low order occur only when the dietary intake is approximately 0.2 mg./1000 calories or less.

Johnson (2) used an oral load test in which 5 mg. of thiamine was administered and concluded that an output of less than 20 mcg. in 4 hours was subnormal. With this same test, Goldsmith and Sarett (104) found that 7 persons on normal diets excreted over 150 mcg. in 4 hours; 5 subjects on diets containing 0.2 to 0.3 mg. of vitamin B_1 per 1000 calories excreted less than 50 mcg. Melnick and Field (102) reported lower excretions in deficient than in normal subjects with load tests in which thiamine was given intramuscularly. Ruffin et al. (64) reported a significant difference in the excretion of thiamine in a 4-hour period by normal persons and patients with clinical findings of mild deficiency of the B vitamins, when 1 mg. was given intramuscularly. Oldham et al. (97) concluded that load test excretions gave a better idea of tissue stores than did the output in 1 hour during fasting or in a 24-hour period.

Of other tests available for assessing thiamine nutrition, estimation of the thiamine content of whole blood and of the erythrocytes and leukocytes merits further study. Foltz et al. (78) reported that the thiamine content of whole blood tends to correspond to the character of the diet but does not correlate well with urinary excretion. Greenberg and Rinehart (105) found the thiamine content of whole blood relatively static and not readily affected by changes in intake. Oldham et al. (97) reported a decrease in thiamine levels in the blood when the thiamine intake was 0.14 mg. per 1000 calories. Hennessy (106) emphasized that virtually all of the thiamine of blood is found in the cellular elements, so that a mere statement of findings without including an hematocrit determination is almost meaningless. It is preferable to know the thiamine content of the total cells, the hematocrit, and the white count. Erythrocytes contain about 8.6 mcg. and leukocytes, 70.6 mcg. per 100 cc. Studies of the thiamine content of the white cell platelet layer might be profitable.

The estimation of cocarboxylase in whole blood was considered by Goodhart and Sinclair (79) to be a reliable method of evaluating saturation of the tissues with thiamine while determination of thiamine in plasma was not satisfactory. Hennessey (106) has stated that there is almost no free thiamine in plasma. Hulse (99) reported a decrease in the yeast-stimulating activity of plasma in subjects on a diet low in thiamine. Further investigation is certainly needed before any of these tests can be applied in surveys.

Pyruvic acid determinations during fasting, after glucose, or after exercise are useful in evaluating thiamine nutrition, particularly in individuals. These methods require considerable care, are time-consuming, and are not readily applicable to surveys. Furthermore, many pathologic conditions other than thiamine deficiency are associated with a rise in pyruvic acid in the blood. Stotz and Bessey (82) suggested that the determination of both pyruvic and lactic acids with computation of the lactate-pyruvate ratio was of assistance in evaluating thiamine nutrition. Goldsmith (83) reported similar findings. Determination of blood pyruvate or of the lactate-pyruvate ratio after a standard exercise test may be informative of nutritional status and is worthy of further investigation (107) (83). Melnick (102) stated that

urinary thiamine values were more sensitive indicators of changes in thiamine intake and of thiamine stores than were tests related to carbohydrate metabolism.

The thiamine content of muscle has been shown to decrease in thiamine deficiency (99). Muscle biopsies are not difficult to obtain and studies of the concentration of thiamine and other vitamins in such specimens should be undertaken.

Riboflavin.—Methods for the determination of riboflavin which are applicable to surveys include estimation of the quantity in the blood (serum and erythrocytes) and measurement of the urinary excretion for one hour during fasting and for several hours after the oral or parenteral administration of a test dose of riboflavin. Two types of procedures for the determination of riboflavin have been commonly employed, (1) microbiological and (2) fluorometric. In the microbiological method (108), *Lactobacillus casei* is the test organism and bacterial response is measured by titration of acid formed or turbidometrically. The fluorometric procedures have included those of Hodson and Norris (109) and of Conner and Straub (110) with numerous modifications. Ferrebee (111) introduced a "direct" method in which the adsorption procedure was omitted, and Najjar (112) proposed a fluorometric method applicable to biological materials. Bessey and Lowry (3) developed a micromethod in which riboflavin is determined in 15 cu. mm. of red cells by the rate of acid production by *Lactobacillus casei.* Fluorometric methods check well with the microbiological procedure if interfering fluorescent substances can be removed. This is at times difficult or impossible with biological materials such as urine. The direct method of Ferrebee (111) or Johnson's field method (6) are more rapid for mass studies but less accurate. The microbiological test is more specific and has a high degree of accuracy but requires considerable time and equipment.

In general, the amount of riboflavin excreted in the urine parallels the dietary intake until high levels are reached, at which time quantitative excretion is increased but the percentage of the intake excreted is little affected (113). Excretion may be dependent in part on the protein content of the diet (114) (115). Furthermore, Perlzweig (116) has shown that after 4 days of fasting, riboflavin excretion may be very high. Sure and Ford (117) reported a marked increase in the output of riboflavin in experimental animals when the diet was restricted in thiamine.

The excretion of riboflavin in 1 hour during fasting has been used by Najjar and Holt (100), Johnson (50), Kark and Bean et al. (23), and others, as an index of nutritional status. Kark and Bean et al. (23) showed a good correlation between the intake of riboflavin and the fasting 1-hour excretion of this vitamin. Brewer (113) found good correlation between the average excretion in 24 hours and in 1 hour during fasting. Similar findings were reported by Davis et al. (118) up to a certain level of intake. Hagedorn (119) reported fair agreement of the output in 1 hour with that in 24 hours. Johnson (2) has suggested that a fasting excretion of less than 20 mcg. per hour (with a rapid fluorometric method) is indicative of chemical deficiency. Cogswell et al. (120), in a study of subjects on diets containing 0.3 mg. of riboflavin daily, found an excretion averaging 16 mcg. in 1 hour. Holt (121) considered a level approaching zero evidence of deficiency. In infants on a diet free of riboflavin, he found a minimal 24-hour urinary excretion of 40 to 50 mcg. which

would be about 2 mcg. per hour. Goldsmith and Sarett (104), using the microbiological method, found an excretion of 2 to 5 mcg. in one hour during fasting in 3 patients maintained for 5 to 6 weeks on a diet containing .5 mg. of riboflavin daily. The exact values reported by several groups of workers cannot be compared because of differences in the methods used.

Feder, Lewis, and Alden (122) reported that measurement of riboflavin in terms of concentration per cc. of urine gave a better index than did concentration per unit of time. Hathaway (123), however, found no relationship between riboflavin excretion and urinary volume. Kark (23) found a lower fasting excretion among Indians than among occidental troops. In the former, folliculosis, corneal invasion, and cheilosis were frequent findings. Hou and Dju (124) found riboflavin excretion (24-hour) lower in patients with glossitis, cheilosis, and eye signs of riboflavin deficiency than in normal persons. The amount of riboflavin excreted was usually proportional to the volume of urine and paralleled thiamine excretion.

The usefulness of load tests in evaluating riboflavin nutrition is the subject of much controversy. The size of the test dose has varied markedly and the usual differences of opinion have been expressed concerning the merits of oral or parenteral administration. Johnson (2) used a 5 mg. oral dose and considered an output of less than 200 mcg. in 4 hours evidence of unsaturation. Goldsmith and Sarett (104) in a study of 5 individuals maintained for 5 to 6 weeks on a diet containing 0.5 mg. riboflavin, found an excretion of 1.1 to 1.6 mg. in 4 hours after giving 5 mg. orally, while a small group of well-nourished persons excreted 1.5 to 3.9 mg. Davis et al. (118) noted a progressive increase in riboflavin excretion after an oral test dose of .02 mg. per kg. body weight as dietary levels were raised from .29 to .66 mg. of riboflavin per 1000 calories. No further increase occurred with higher intakes.

Brewer (113) found good correlation between the average excretion in 24 hours and the excretion for 4 hours after an oral dose of 3 mg. Correlation between the 1-hour fasting excretion and the test dose was not significant. Feder et al. (122) found a coefficient of correlation of .61 between the fasting excretion and the per cent of the test dose (.016 mg. per kg. intramuscularly) recovered in the urine. They concluded that saturation levels seldom gave more information than the fasting morning specimen. Hagedorn et al. (119) found that the retention of riboflavin supplements varied widely without apparent reason, and criticized the use of load tests as evidence of riboflavin deficiency.

Riboflavin in blood has been measured by the microbiological method using either macro- (125) (126) or micro- (3) procedures. Axelrod et al. (127) found no difference in the riboflavin content of the blood of normal persons and of patients with riboflavin deficiency. Holt (121) has recently studied infants on a riboflavin-free diet and found that riboflavin disappeared from the serum and that there was a marked reduction in the content of the erythrocytes and leukocytes. When the dietary intake of riboflavin was increased to .40–.45 mg. per day riboflavin was again present in the serum and the level in the erythrocytes and leukocytes returned to normal. Riboflavin was determined with the method of Burch, Bessey, and Lowry (128) which requires special apparatus not readily available. Determination of riboflavin in blood, particularly in the cellular components, may prove useful in nutritional surveys and deserves further investigation.

Niacin.—Chemical tests for the appraisal of niacin nutrition have been numerous but far from satisfactory. Niacin is excreted in the urine in various forms, as N′ methylnicotinamide, small amounts of niacinamide and nicotinic acid, as nicotinuric acid, and in the form of a pyridone compound. Niacin and its amide may be determined by a microbiological procedure using *L. arabinosus* as the test organism (129) (130) or by chemical methods involving the König reaction, with cyanogen bromide and an aromatic amine, to form a colored compound (60).

Various procedures including hydrolysis with strong acid or alkali and removal of interfering substances, followed by application of the cyanogen bromide reaction (131) (132) have been used for measurement of niacin derivatives. The most important of these was thought at one time to be trigonelline but was later shown to be N′ methylnicotinamide. Procedures for the fluorometric determination of N′methylnicotinamide (F2) have been devised by Najjar and Wood (133), Huff and Perlzweig (134) and others. A simplified and sensitive method involving condensation of N′ methylnicotinamide with acetone, in alkaline solution, has recently been proposed by Huff and Perlzweig (135).

Recently Knox and Grossman (136) have isolated a pyridone from urine, N′ methyl-6-pyridone-3-carboxylamide, which seems to be the major excretory product of niacin (137). The method for determination of this pyridone is at present extremely difficult and simplification is essential for application to studies of human niacin nutrition. Perlzweig (138) has recently developed a procedure which may fill this need.

In the analysis of whole blood for niacin, results should be expressed in terms of hematocrit values or red cells since practically all the niacin is found in the erythrocytes, the amount in the plasma being negligible. The nicotinic acid of the cells is present almost entirely as pyridine nucleotides (139). Microbiologic assays employing *Hemophillus influenzae* and *parainfluenzae* are available for determining these metabolites and are simpler than chemical procedures. The fluorometric method employing condensation with acetone has recently been applied to the determination of pyridine nucleotides in cells and tissues (135). Carter and O'Brien (140) studied normal persons and patients with various diseases and concluded that the concentration of niacin in blood did not provide a useful nutritional guide. Axelrod et al. (141) and Kohn and Bernheim (142) reported that the determination of coenzyme I in the blood offered little diagnostic information in borderline cases of deficiency disease. These workers found an increase in coenzymes after niacin was administered. Youmans (143) stated that the level of coenzymes in blood failed to show close correlation with niacin deficiency. Vilter and associates (144) found that the blood level of codehydrogenase was lower in 3 pellagrins than in 4 normal persons.

Blood methods have not been used extensively in the investigation of niacin metabolism and there is a paucity of data concerning the levels of pyridine nucleotides in whole blood or in the cellular elements at various levels of nutrition. Further investigation along this line may be worthwhile despite the negative findings indicated above.

Numerous studies of the excretion of niacin derivatives in the urine have been carried out. There is little change in the urinary excretion of freely hydrolyzable derivatives of niacin with variations in diet, and only a slight decrease occurs in

pellagra. Early reports, with the use of cyanogen bromide methods, showed that the urinary excretion of "trigonelline" was decreased in persons with niacin deficiency. A diminished output was found both in 24-hour specimens and in urine collected following the administration of a test dose of niacinamide (145) (146) (147).

In recent investigations the excretion of N′ methylnicotinamide has been measured in the fasting 1-hour urine and after the administration of a test dose of niacinamide. Many difficulties are involved in interpreting findings in these tests. The excretion of N′ methylnicotinamide accounts for only about 20 to 30 per cent of niacinamide given as a test dose (148) (149). Wide variations have been observed between individuals in the percentage of niacinamide excreted as methyl derivatives. The rate of methylation or the available methyl supply of the body may be important in this regard. However, determination of N′ methylnicotinamide appears to be the only procedure, applicable to urine, which is practical at the present time for use in surveys.

It is generally agreed that findings obtained should be interpreted with caution in evaluating niacin nutrition. Mickelsen and Erickson (150) found no difference in the excretion of subjects receiving .1 to 10 mg. of niacin per day over a period of 1 month. They concluded that determination of N′ methylnicotinamide in the 24-hour urine was of little value. Ruffin et al. (64) and Sargent et al. (151) reported that the urinary excretion of N′ methylnicotinamide correlated reasonably well with dietary and clinical evidence concerning bodily niacin stores. Holt and Najjar (152) reported the disappearance of F_2 in pellagra and its reappearance after vigorous therapy. They proposed the routine measurement of F_2 in surveys and suggested that if this substance was absent from the urine in the post-absorptive state, the niacin stores were low. Johnson (2) considered that an excretion of .03 mg. of N′ methylnicotinamide or less in 1 hour during fasting indicated unsaturation. However, it has been shown that normal persons occasionally excrete no N′ methylnicotinamide in the fasting specimen (151). Perlzweig (116) found little change in the excretion of N′ methylnicotinamide during a 4-day fast and Sargent (151) reported a high output in one man who fasted 16 days. Cayer and Cody (153) found an increased excretion of niacin derivatives in sprue associated with marked muscle wasting.

Following the administration of a test dose of niacinamide, there is a prompt rise in N′ methylnicotinamide excretion in normal subjects, reaching a maximum in 2 to 4 hours (100, 103, 154, 148). Occasionally a normal individual fails to show this increase (151). A high excretion of N′ methylnicotinamide may be more significant than a low excretion in the absence of prolonged fasting or wasting of muscles. Johnson (2) has suggested that an excretion of less than 0.5 mg. in 4 hours after administering 50 mg. of niacinamide orally indicates chemical deficiency. Cogswell et al. (120) showed that a decrease in N′ methylnicotinamide excretion after an intravenous dose of niacinamide occurred in 7 patients on a diet deficient in the B vitamins.

There are numerous reasons for the discrepancy of findings obtained by these and other investigators. Many different methods of analysis have been used and wide variations between individuals and in the same individual on different days have been demonstrated. As previously noted, there may be marked individual differences in the percentage of various metabolites of niacin which are excreted. Such differences

may be due in part to the methylating ability of the organism. Furthermore, as Knox (137) has shown, N′ methylnicotinamide is not the major metabolite of niacin excreted in the urine of man.

A still more important factor leading to confusion in interpretation of data may be the relationship between tryptophane and niacin metabolism. Sarett and Goldsmith (155) and Perlzweig and coworkers (156) showed a marked increase in the excretion of N′ methylnicotinamide following the administration of tryptophane to persons on both normal and restricted diets. The increase appeared to be proportional to the amount of tryptophane given (157). Analysis of diets for tryptophane, as well as for niacin content, is essential if any correlation between dietary intake and urinary excretion is attempted. The whole field of niacin metabolism needs reevaluation. Studies at various levels of niacin and tryptophane intake, including investigation of patients with clinical pellagra, must be carried out. The urinary excretion of the pyridone compound of niacin (136) must be measured under various experimental conditions. It should not be too long before better tests are available and more accurate knowledge of the value of present tests can be ascertained.

One may conclude that, at present, the determination of N′ methylnicotinamide in the urine during fasting and after the administration of a test dose of niacinamide are worthwhile procedures in the assessment of nutritional status if conservative interpretation is applied to the findings.

ASCORBIC ACID

Ascorbic acid has been one of the most extensively studied of the essential nutrients and numerous tests have been proposed for the appraisal of ascorbic acid nutrition. In comparing the merits of various methods, evaluation would be much easier if some standardization of procedures had been attempted. Lack of agreement is particularly frequent in regard to load tests, which are almost as numerous as the investigators working in this field.

In the measurement of vitamin C in biological materials, the oxidation reduction properties of ascorbic acid are widely used as the fundamental reaction. The reducing capacity of acid extracts of the test material are measured by treatment with an oxidizing reagent, of which 2,6-dichlorophenolindophenol has been found the most satisfactory. Visual titration techniques (158, 159, 160, 161) and photometric methods (162, 163, 164, 165) based on this reagent have been applied in analyses of blood and urine. Visual titration may be inaccurate in extracts which contain water- or acid-soluble pigments, or reducing agents other than ascorbic acid which react rapidly with the dye and produce interference with the end point. Photometric methods partially overcome these difficulties. Many procedures for the removal of pigments and of interfering reducing substances have been suggested (60). Dehydroascorbic acid may be determined by the reaction with 2,4-dinitrophenylhydrazine to form an osazone which is converted to a red pigment upon treatment with sulfuric acid. This is the basis of the Roe and Oesterling (166) method for determining total ascorbic acid of whole blood and urine, and of the micromethod of Bessey, Lowry, and Brock (167) for estimation of ascorbic acid in blood. These methods are rapid and possess a high degree of specificity.

Tests for assessment of nutritional status include determination of the level of

ascorbic acid in the plasma, whole blood, and white cell and platelet layer, and estimation of the urinary excretion during fasting and in a 24-hour period. In addition, a number of load tests have been proposed in which changes either in blood levels or in the urinary excretion of ascorbic acid are determined, for varying periods of time, after administering an oral or parenteral dose of ascorbic acid.

The level of ascorbic acid in the plasma during fasting corresponds in general with the dietary intake of this vitamin (23, 168, 169, 170, 171). Determination of this level has been a method commonly used in surveys because of the ease with which specimens can be obtained and the relative simplicity of the laboratory procedure. The significance of findings has been extremely controversial. Temporary fluctuations in plasma ascorbic acid are frequent (172), and there is a wide range of values at any given level of intake. Dodds and MacLeod (173) have recently reported mean values, together with ranges and standards of deviation, for 41 women receiving 32, 57, 82, and 107 mg. of vitamin C daily. These and similar findings should be useful in interpreting survey data. If recent intake has been liberal, 75 to 100 mg. daily, values of 1.0 to 1.4 mg. per 100 cc. will be obtained; if only 15 to 25 mg. has been included in the diet, values of 0.3 mg. or lower will be found (174).

Controversy has been chiefly concerned with the meaning of low levels of plasma ascorbic acid and determination of the point at which a deficiency state may be said to exist. Levels ranging from 0.3 to 0.7 mg. per 100 cc. of blood have been suggested as the lower limit of normal by various workers. If concentrations below these levels indicate an unsatisfactory state of nutrition, large segments of the population fall in this classification (38). In the opinion of several investigators, levels as low as 0.1 to 0.3 mg. per cent are not indicative of deficiency but merely reflect a low recent dietary intake or suggest that the body is not saturated with vitamin C. It has been emphasized that unsaturation is compatible with normal health. Ruffin et al. (64), Johnson (175), and others have reported plasma levels of zero in persons without clinical signs of scurvy. Johnson found that when healthy adults were placed on a diet containing no vitamin C, the serum ascorbic acid fell to zero in about 8 weeks. In Crandon, Lund, and Dill's experiment (176), plasma levels were zero for 13 weeks before clinical scurvy became evident, while leukocyte levels reached zero just prior to this. Lowry et al. (177) and Linghorne (178) noted a fall in the ascorbic acid of the serum to 0.2 mg. per cent on a daily intake of either 8 or 23 mg. of ascorbic acid. A definite relationship was shown to exist between the concentration in the serum and in the white cells. Serum levels of 0.4 mg. per cent or above were associated with concentrations in the leukocytes of more than 20 mg. per cent, while serum levels under 0.3 mg. per cent were associated with concentrations in the leukocytes of less than 20 mg. per cent. With a white cell value of one-half of normal, serum ascorbic was not zero but measured 0.1 to 0.4 mg. per cent. Realimentation studies indicated that the leukocytes appeared to be a valid index of total body concentration.

Bessey (3) found measurable differences in ascorbic acid in the serum of 3 groups of New York school children of different economic background. Farmer (169) found that in normal men, on a diet containing 0 to 10 mg. of vitamin C, the plasma ascorbic acid reached zero in 70 days. Serum levels below 0.3 mg. per cent have been considered indicative of chemical deficiency by Johnson (2). Dogramoci (179) found

plasma levels of 0.0 to 0.3 mg. per cent (average .087) in 24 cases of scurvy. Vilter et al. (180) reported levels of 0.0 in 19 adults with scurvy and McMillan and Inglis (181) a mean of 0.05 mg. per cent in 22 subjects with this deficiency disease. Johnstone (182) found that a marked change in intake will be reflected by a change in the concentration in the blood during fasting in 1 to 2 weeks. Milam and Wilkins (183) showed that low plasma levels could be raised in a 6-week period by feeding an adequate diet.

Munks (184) in a study of vitamin C nutrition in pregnancy concluded that determination of ascorbic acid in the blood and urine was an unreliable index of nutritional status. Smith (185) stated that ascorbic acid in maternal blood was correlated with the dietary intake and with the level in the cord blood of the infant. In numerous disease states there is a decrease in the concentration of plasma ascorbic acid. This should be considered in evaluating results in studying certain weighted samples of the population.

In the majority of studies, little or no correlation has been demonstrated between the amount of ascorbic acid in the plasma or the degree of saturation of the tissues with vitamin C, and changes in the gums ascribed to deficiency of this nutrient (43, 37, 186, 187, 188, 189). In a few studies, the incidence of gingivitis appeared to be related to ascorbic acid intake or to plasma levels (180, 178, 191). In experimental deficiency, gum changes do not occur before other signs of scurvy (176)(169).

Although low concentrations of plasma ascorbic acid are found in the absence of clinical scurvy, this does not mean that such findings are of no significance. If the mean plasma level in a population group is low, it appears likely that the intake has been poor for long periods of time and that bodily stores have been depleted. Plasma levels of less than 0.3 mg. per cent are regarded by nearly all investigators as suggestive of chemical deficiency; many of those who have studied the problem most carefully consider that levels below 0.6 mg. per cent are indicative of an intake that is less than desirable.

The only tests of urinary excretion which can be used in surveys are those requiring brief periods for collection. The excretion in 1 hour during fasting or in several hours after a test dose of ascorbic acid may be determined. Close correlation has been reported by Johnson (50) between the average daily intake of ascorbic acid and the excretion in the urine before breakfast. The significance of this correlation has been questioned by Berryman (52). Interpretation of findings in the fasting urine in group surveys should be conservative.

Load tests for the assessment of ascorbic acid nutrition have employed varied dosage (either according to body weight or an arbitrary amount) administered orally or intravenously, and collection periods for urine or blood have ranged from 1 to 24 hours. In the evaluation of these tests, a certain percentage of the test dose excreted has been considered indicative of saturation, another percentage of deficiency. These percentages have been chosen by comparing findings in normal persons with those in patients with deficiency disease or by testing individuals under carefully controlled experimental conditions on various levels of intake. The numerous procedures suggested cannot be enumerated here (192)(143). A few recent studies will be mentioned which bear on the validity and interpretation of load tests.

Johnson, Darling, et al. (175) showed that the excretion of ascorbic acid for 3 and

6 hours after giving 1 gm. of the vitamin orally, definitely reflected the intake of subjects whose bodily stores were known to be very low, average, or high by virtue of subsistence on diets lacking, normal, or high in vitamin C. The level of serum ascorbic acid was distinctly different in the deficient and supplemented groups. In another study, Johnson and coworkers (2) suggested that an excretion of less than 3 mg. in 4 hours after an oral test dose of 500 mg. of ascorbic acid was indicative of chemical deficiency.

Farmer (169) studied normal men on a diet containing 0 to 10 mg. of vitamin C daily and conducted a saturation test employing an oral dose of 15 mg. per kg. of body weight, with measurement of ascorbic acid in the blood and urine every hour for 5 hours. This test was reported to be a reliable index of tissue depletion. Holland et al. (193), using the saturation test of Wright and coworkers (194) (1 gm. of ascorbic acid intravenously with determination of the $1\frac{1}{2}$- and 5-hour urinary excretions), found a satisfactory correlation between the 5-hour excretion and the fasting level in the plasma in 85 per cent of 48 cases. Haines et al. (170) found that on daily intakes of 33 to 70 mg., the excretion in 24 hours after an oral test dose of 400 mg. corresponded with the intake. Youmans (143) pointed out that the findings with load tests paralleled findings in the plasma during fasting.

Kajdi et al. (195) concluded that a correlation existed between load tests and the clinical diagnosis of ascorbic acid deficiency or adequacy in infants. The test recommended by him consisted of measurement of plasma ascorbic acid 4 hours after the intramuscular injection of 200 mg. of ascorbic acid.

Berryman (52) concluded that correlation between the urinary excretion during fasting and the excretion following load tests appeared to be good at extremes of intake but less significant at intermediate levels. Kark et al. (23) in a study of troops in tropical areas found a correlation between the intake of ascorbic acid and the concentration in the serum and urinary excretion.

In various surveys, low concentrations of plasma ascorbic acid have been interpreted as indicative of a high incidence of deficiency of this vitamin. It might better be stated that the dietary intake had been low, that ascorbic acid reserves were reduced in a large sample of the population, and that chemical deficiency was presumably present in a certain percentage of this group. Investigation of the dietary history, measurement of ascorbic acid in the leukocytes, and the administration of load tests, can give additional information regarding the presence and severity of tissue depletion. Plasma levels mirror more closely the diet; white cell levels, the tissue stores.

VITAMIN D AND CALCIUM

In the appraisal of nutritional status in regard to calcium and vitamin D, only two procedures have been used in nutritional surveys: the determination of the level of calcium in the blood and the measurement of alkaline phosphatase in the serum. There are, at present, no chemical methods which permit estimation of vitamin D in biological materials of low potency (60). Studies of vitamin D in the blood are impractical and studies of excretion are lacking.

It has been recognized for a number of years that alkaline phosphatase increases

in the serum in rickets and in a number of other diseases associated with abnormalities in the metabolism of bone. In 1933, Bodansky (196) proposed a method for determining alkaline phosphatase which has been used extensively. In 1946, Bessey et al. (197) developed a microprocedure using 3 to 20 cu. mm. of serum in which the amount of enzyme was measured with p-nitrophenyl phosphate as the substrate. There was only slight divergency of results with the two methods. The normal level of alkaline serum phosphatase is stated to be 3 to 12 Bodansky units in children up to the age of 12, and 3 to 5 units in adults. Klasmer (198) found values of 5.6 to 15 units in 320 healthy children between the ages of 6 months and $2\frac{1}{2}$ years.

Alkaline serum phosphatase is elevated early in rickets and parallels the activity of the disease and the healing process. In mild rickets, the level may be 20 to 30 units, in severe rickets as high as 60 units (199). Determination of serum phosphatase is a reasonably reliable and accurate, although not specific, method of diagnosing early rickets and hypovitaminosis D. Other causes of an increase in phosphatase activity are uncommon at the age when rickets is prevalent and are easily detected (143). In adults and in children over 5 years, elevation of alkaline phosphatase in the serum is uncommon (200) and has been considered to be of doubtful significance. Recently Bessey (201) has found a slight increase in phosphatase in certain groups of children and has suggested that determination of this enzyme may be a useful tool, comparable to hemoglobin, in nutrition surveys. More data should be obtained in persons of all age and sex groups and under various conditions of metabolic activity.

Many diseases are of etiologic importance in variations in the concentration of phosphatase in older persons, and the likelihood of a relationship to vitamin D deficiency is not great. In China, a decided increase in phosphatase activity has been noted in osteomalacia. In a recent survey in Newfoundland, it was concluded that vitamin D deficiency was infrequent because few clinical signs of rickets were observed and low serum phosphatase values were obtained (71). The value of including phosphatase determinations in surveys other than those involving infants and young children remains to be determined.

Determination of the calcium and phosphorus content of blood has been used in the diagnosis of rickets and osteomalacia and in evaluating the severity of these conditions in individual subjects. Methods for these determinations are well known (202).

In nutrition surveys, particularly of adults, estimation of the calcium content of blood has not appeared to be worth while in the United States or Europe. Calcium deficiency of sufficient degree to produce changes in the blood is uncommon in these areas and interpretation of borderline findings in older children or in adults is extremely difficult. In studies of infants, or in certain adult populations in the Far East, estimation of the level of blood calcium may be a valuable part of survey techniques.

The normal concentration of calcium in the blood ranges from 9 to 11 mg. per cent in adults (203) and from 10 to 11 mg. per cent in children (204). Macy (202) found average values for calcium and phosphorus of 10.4 and 5.6 mg. per cent respectively in a group of children 5 to 12 years of age. If serum calcium falls to low levels, the clinical syndrome of tetany or osteomalacia occurs.

OTHER TESTS

Routine urinalysis—Ketone bodies in urine and blood—Chlorides in urine and blood:

In studies of population groups, routine urinalysis should be carried out whenever possible, including determination of specific gravity, qualitative tests for albumin and sugar, and microscopic examination of the sediment. The information obtained will assist in detecting medical defects which may be responsible for malnutrition and which may explain loss of weight, hypoproteinemia, anemia, and other findings in certain members of the group examined.

In certain surveys, it may be desirable to test for depletion of water and salt and to determine whether or not ketosis is present. An increase in blood ketones and ketonuria occurs in a number of disease states including complete and partial starvation. In childhood particularly, even short periods of inadequate carbohydrate intake may lead to ketosis (205). Problems of ketosis in relation to physical performance without food have been discussed by Keys (206). Analysis of urine for the presence of acetone bodies is a simple procedure which can readily be included in surveys of severely malnourished populations (6).

Water and salt deficiency are important problems in hot environments, especially in persons engaged in heavy labor. Dill (207) has shown that water expenditure may amount to 8 to 10 liters in 24 hours. A large part of the water loss is composed of sweat which also removes sodium and chloride from the body, and rapid dehydration may develop. Problems of electrolyte balance may be further complicated if vomiting or diarrhea occurs. Marriott (208) has emphasized that differentiation should be made between pure water depletion, pure salt depletion, and mixed depletion of both water and salt. Such differentiation is vitally important in evaluation of the water and electrolyte balance of individuals but is difficult to accomplish in surveys. Since combined depletion or pure salt deficiency are the common findings, the procedures of most value in surveys are the detection of hemoconcentration and the determination of plasma and urine chlorides.

Dehydration is suggested by a concentration of serum protein above 7.5 gm. per 100 cc. of blood (2) or by an increase in the volume of erythrocytes as measured by the hematocrit (205). The concentration of hemoglobin may also be increased.

In salt deficiency there is a diminution or absence of chlorides in the urine (208). A simple procedure for determination of urinary chloride is that of Fantus (208), or the method of Harvey has proved satisfactory (7). Johnson has suggested that an output of less than 0.2 gm. of sodium chloride per hour or a fasting serum chloride of less than 98 milliequivalents per liter is chemical evidence of salt deficiency. Talbott (209) considers that 100 milliequivalents per liter is the minimum normal concentration of serum chloride. In a study of persons with heat cramps, he found that the concentration of chloride in the urine was usually below 40 milliequivalents per liter. Marriott (208) has pointed out that the levels of chloride or sodium in the serum may not give accurate information as to the loss of sodium chloride from the body in states of mixed depletion where the loss of water is greater than that of salt. Detailed discussion of water and salt deficiency and of electrolyte balance may be found in several excellent reviews (205, 208, 209).

In a survey of troops in Southeast Asia, Kark et al. (23) found satisfactory levels of urinary and serum chlorides especially in units who salted their water or their atta. In certain hard-working units, however, where the importance of salt was either unrecognized or ignored, low serum chloride concentrations and low urinary chlorides were observed. Collapse and abdominal and muscular cramps were reported to have occurred in these units.

SUMMARY

Considerable progress has been made in the biochemical evaluation of nutritional status. Tests have been devised which are indicative of the previous dietary intake of nutrients, methods are available for estimating saturation or depletion of bodily stores of certain chemical substances, and there are a few tests which measure the metabolically active forms of dietary essentials and the abnormalities which occur in deficiency disease. Although exact criteria for the interpretation of findings in terms of deficiency, adequate, or optimal nutrition are lacking in most instances, chemical tests are a valuable part of survey techniques in obtaining a general picture of the nutritional level of population groups. Findings should be reported in terms of actual figures obtained or in the form of distribution curves rather than as deviations from a mean. This will permit reinterpretation of data when more accurate criteria for evaluation are available.

The use of micromethods has greatly facilitated the application of chemical tests to mass examination and should assist in solving many existing problems. New tests are needed and experiments under carefully controlled conditions with existing methods should yield valuable data. In the future, biochemical examination will undoubtedly be an integral part of all nutrition surveys.

BIBLIOGRAPHY

1. Dann, W. J. and Darby, W. J.: Appraisal of Nutritional Status (Nutriture) in Humans, with Especial Reference to Vitamin Deficiency Diseases. Physiol. Rev., *25:* 326–346, 1945.
2. Johnson, R. E., Sargent, F., Robinson, P. F., and Consolazio, F. C.: Assessment of Nutritional and Metabolic Condition in the Field; General and Clinical Aspects. War Medicine, *7:* 227–233, 1945.
3. Bessey, O. A. and Lowry, O. H.: Biochemical Methods in Nutritional Surveys. Am. J. Pub. Health, *35:* 941–946, 1945.
4. Pett, L. B.: Errors in Applying Nutrient Allowances to Dietary Surveys or Food Policies. Canad. J. Pub. Health, *36:* 69–73, 1945.
5. Lowry, O. H. and Bessey, O. A.: Microchemical Methods for Nutritional Studies. Fed. Proc., *4:* 268–271, 1945.
6. Johnson, R. E.: Field Nutritional Laboratory. War Medicine, *7:* 222–226, 1945.
   Johnson, R. E., Sargent, F., Robinson, P. F., and Consolazio, F. C.: Estimation of Riboflavin, Thiamine, and N′-Methylnicotinamide—Rapid Field Methods. J. Ind. & Eng. Chem., Anal. Ed., *17:* 384–386, 1945.
7. Barbour, H. G. and Hamilton, W. F.: The Falling Drop Method for Determining Specific Gravity. J. Biol. Chem., *69:* 625, 1926.
8. Kagan, B. M.: A Simple Method for the Estimation of Total Protein Content of Plasma and Serum. J. Clin. Invest., *17:* 369–372, 1938.
9. Phillips, R. A., Van Slyke, D. D., Dole, V. P., Emerson, K., Jr., Hamilton, P. B., and Archibald, R. M.: Copper Sulfate Method for Measuring Specific Gravities of Whole Blood and Plasma. Bull. U. S. Army Med. Dept., *71:* 66–83, 1943.

10. Lowry, O. H. and Hunter, T. H.: Determination of Serum Protein Concentration with a Gradient Tube. J. Biol. Chem., *159:* 465–474, 1945.
11. Atchley, J., Bacon, R., Curran, G., and David, K.: Clinical Evaluation of Copper Sulfate Method for Measuring Specific Gravities of Whole Blood and Plasma. J. Lab. & Clin. Med., *30:* 830–838, 1945.
12. Robinson, H. W., Price, J. W., and Hogden, C. A.: Estimation of Albumin and Globulin in Blood Serum; A Study of Errors Involved in Filtration Procedure. J. Biol. Chem., *120:* 481–498, 1937.
Separation of Fractions by Centrifugation with an Angle Centrifuge. Ibid., *126:* 207–212, 1938.
Precipitation of Globulin at 25° by Sodium Sulfate. Ibid., *126:* 213–216, 1938.
13. Campbell, W. R. and Hanna, M. I.: Albumin, Globulin, and Fibrinogen of Serum and Plasma. J. Biol. Chem., *119:* 15–33, 1937.
14. Lerner, A. B. and Barnum, C. P.: A New, Rapid Method for Determination of Serum Albumin and Globulin by Ultraviolet Absorption. Arch. Biochem., *11:* 505–514, 1946.
15. Peters, J. P. and Eisenman, A. J.: Serum Protein in Diseases not Primarily Affecting the Cardiovascular System or the Kidneys. Am. J. Med. Sci., *186:* 808–833, 1933.
16. Youmans, J. B., Patton, E. W., Sutton, W. R., Kern, R., and Steinkamp, R.: Surveys of Nutrition of Populations; Protein Nutrition of a Rural Population in Middle Tennessee. Am. J. Pub. Health, *33:* 955–964, 1943.
17. Metcoff, J., Favour, C. B., and Stare, F. J.: Plasma Protein and Hemoglobin in the Protein-Deficient Rat; A Three-Dimensional Study. J. Clin. Invest., *24:* 82–91, 1945.
18. Madden, S. C. and Whipple, G. H.: Plasma Proteins: Their Source, Production, and Utilization. Physiol. Rev., *20:* 194–217, 1940.
19. Sachar, L. A., Horvitz, A., and Elman, P. J.: Studies on Hypoalbuminemia Produced by Protein-Deficient Diets; Hypoalbuminemia as a Quantitative Measure of Tissue Protein Depletion. J. Exper. Med., *75:* 453–459, 1942.
20. Stare, F. J. and Davidson, C. S.: Protein: Its Role in Human Nutrition; Introduction. J.A.M.A., *127:* 985–989, 1945.
21. Milam, D. F.: Plasma Protein Levels in Normal Individuals. J. Lab. & Clin. Med., *31:* 285–290, 1946.
22. Hegsted, D. M., Tsongas, A. G., Abbott, D. B., and Stare, F. J.: Protein Requirements of Adults. J. Lab. & Clin. Med., *31:* 261–284, 1946.
23. Kark, R. M., Aiton, H. F., Pease, E. D., Bean, W. B., Henderson, C. R., Johnson, R. E., and Richardson, L. M.: Tropical Deterioration and Nutrition; Clinical and Biochemical Observations on Troops. Medicine, *26:* 1–40, 1947.
24. Keys, A., Taylor, H. L., Mickelsen, O., and Henschel, A.: Famine Edema and the Mechanism of Its Formation. Science, *103:* 669–670, 1946.
25. Lipscomb, F. M.: Medical Aspects of Belsen Concentration Camp. Lancet, *2:* 313–315, 1945.
26. Evelyn, K. A.: A Stabilized Photoelectric Colorimeter with Light Filters. J. Biol. Chem., *115:* 63–75, 1936.
27. Wintrobe, M. M.: Clinical Hematology. Second Edition. Philadelphia, Pa. Lea and Febiger, 1946.
28. King, E. J., Gilchrist, M., and Delory, G. E.: Accuracy of Haemoglobin Methods. Lancet, *1:* 239–243, 1944.
29. Peters, J. P. and Van Slyke, D. D.: Quantitative Clinical Chemistry, Vol. 2. Baltimore. Williams & Wilkins Co., 1932.
30. Horecker, B. L.: Primary Standard of Colorimetric Determination of Hemoglobin. J. Lab. & Clin. Med., *31:* 589–594, 1946.
31. Blum, L. L.: Photoelectric Determination of Erythrocyte Count; Basic Principles and Technic. Am. J. Clin. Path., Tech. Sec., *9:* 85–93, 1945.
32a. Moore, C. V., Arrowsmith, W. R., Quilligan, J. J., Jr., and Read, J. T.: Studies in Iron Transportation and Metabolism. I. J. Clin. Invest., *16:* 613–626, 1937.

Moore, C. V., Doan, C. A., and Arrowsmith, W. R.: Studies in Iron Transportation and Metabolism. II. J. Clin. Invest., *16:* 627–648, 1937.

32b. Shank, R. E.: Microchemical Procedures and Their Use in the Investigation of Problems in Nutrition. A. P. H. A. Meeting, October 1947.

32c. Cartwright, G. E., Lauritsen, M. A., Jones, P. J., Merrill, J. M., and Wintrobe, M. M.: Anemia of Infection; Hyperferremia, Hypercupremia, and Alterations in Porphyrin Metabolism in Patients. J. Clin. Invest., *25:* 65–80, 1946.

33. Ohlson, M. A., Cederquist, D., Donelson, E. G., Leverton, R. M., Lewis, G. K., Himwich, W. A., and Reynolds, M. S.: Hemoglobin Concentrations, Red Cell Counts, and Erythrocyte Volumes of College Women of North Central States. Am. J. Physiol., *142:* 727–732, 1944.

34. Pedley, F. G.: Haemoglobin Concentration in College Women. Canad. Med. Assoc. J., *51:* 351–353, 1944.

35. Macy, Icie G.: Nutrition and Chemical Growth in Childhood, Vol. 2. Springfield, Illinois Charles C. Thomas, 1946.

36. Milam, D. F. and Muench, H.: Hemoglobin Levels in Specific Race, Age, and Sex Groups of a Normal North Carolina Population. J. Lab. & Clin. Med., *31:* 878–885, 1946.

37. Darby, W. J. and Milam, D. F.: Field Study of the Prevalence of Clinical Manifestations of Dietary Inadequacy. Am. J. Pub. Health, *35:* 1014–1021, 1945.

38. Inadequate Diets and Nutritional Deficiencies in the United States. Bull. No. 109, pp. 1–56, November 1943. Published by the National Research Council, National Academy of Sciences, Washington 25, D. C.

39. A Survey of Hemoglobin Levels in Great Britain in 1939. Nutrition Rev., *4:* 154–156, 1946.

40. Metcoff, J., Goldsmith, G. A., McQueeney, A. J., Dove, R. F., McDevitt, E., Dove, M. A., and Stare, F. J.: Nutritional Survey in Norris Point, Newfoundland. J. Lab. & Clin. Med., *30:* 475–487, 1945.

41. Fullerton, H. W., Mair, M. I., and Unsworth, P.: Survey of Haemoglobin Levels of Poor Classes in Aberdeen. Brit. Med. J., *2:* 373–374, 1944.

42. Davidson, L. S. P., Donaldson, G. M. M., Lindsay, S. T., and Roscoe, M. H.: Nutritional Iron Deficiency Anaemia in Wartime; Haemoglobin Levels of School Children and Pregnant Women in 1944 Compared with Levels in 1942 and 1943. Brit. Med. J. *2:* 333–334, 1944.

43. Milam, D. F. and Anderson, R. K.: Nutrition Survey of an Entire Rural County in North Carolina. South. Med. J., *37:* 597–605, 1944.

44. King, E. J., Gilchrist, M., and Matheson, A.: Haemoglobin Equivalent of B. S. I. Haldane Standard. Brit. Med. J., *1:* 250–252, 1944.

45. Nutritional Status of a Population Group in Madrid. Nutrition Rev., *1:* 231–233, 1943.

46. The Nutritional Situation in Internment Camps in France. Nutrition Rev., *2:* 205–207, 1944.

47. Burger, G. C. E., Sandstead, H. R., and Drummond, J.: Starvation in Western Holland. Lancet, *2:* 282–283, 1945.

48a. Cartwright, G. E. and Wintrobe, M. M.: Hematologic Survey of Repatriated American Military Personnel. J. Lab. & Clin. Med., *31:* 886–899, 1946.

48b. Waldenstrom, J.: Incidence of "Iron Deficiency" (Sideropenia) in Some Rural and Urban Populations. Acta Med. Scandinav., Supp., *170:* 252–279, 1946.

49. Darby, W. J., Hahn, P. F., Kaser, M. M., Steinkamp, R. C., Densen, P. M., and Cook, M. B.: Absorption of Radioactive Iron by Children 7–10 years of Age. J. Nutrition, *33:* 107–119, 1947.

50. Johnson, R. E., Henderson, C. R., Robinson, P. F., and Consolazio, F. C.: Comparative Merits of Fasting Specimens, Random Specimens, and Oral Loading Tests in Field Nutritional Surveys. J. Nutrition, *30:* 89–98, 1945.

51. Johnson, R. E., Contreras, L. A., Consolazio, F. C., and Robinson, P. F.: Comparison of Intravenous and Oral Vitamin Tolerance Tests. Am. J. Physiol., *144:* 58–68, 1945.

52. Berryman, G. H., Henderson, C. R., Wheeler, N. C., Cogswell, R. C., Jr., Spinella, J. R., Grundy, W. E., Johnson, H. W., Wood, M. E., Denko, C. W., Friedemann, T. E.,

Harris, S. C., Ivy, C. A., Youmans, J. B.: Effects in Young Men Consuming Restricted Quantities of B-Complex Vitamins and Protein, and Changes Associated with Supplementation. Am. J. Physiol., *148:* 618–647, 1947.

53. Perlzweig, W. A. and Sarett, H. P.: Unpublished data.
54. Sinclair, H. M.: Wartime Nutrition in England as a Public Health Problem. Am. J. Pub. Health, *34:* 828–832, 1944.
55. Kimble, M. S.: Photocolorimetric Determination of Vitamin A and Carotene in Human Plasma. J. Lab. & Clin. Med., *24:* 1055–1065, 1938–1939.
56. Dann, W. J. and Evelyn, K. A.: Determination of Vitamin A with Photoelectric Colorimeter. Biochem. J., *32:* 1008–1017, 1938.
57. Clausen, S. W. and McCoord, A. B.: Carotinoids and Vitamin A of Blood. J. Pediat., *13:* 635–650, 1938.
58. May, C. D., Blackfan, K. D., McCreary, J. F., and Allen, F. H., Jr.: Clinical Studies of Vitamin A in Infants and in Children. Am. J. Dis. Child., *59:* 1167–1184, 1940.
59. Bessey, O. A., Lowry, O. H., Brock, M. J., and Lopez, J. A.: Determination of Vitamin A and Carotene in Small Quantities of Blood Serum. J. Biol. Chem., *166:* 177–188, 1946.
60. Biological Symposia, Vol. XII. Lancaster, Pa. The Jacques Cattell Press, 1947.
61. Association of Vitamin Chemists, Inc.: Methods of Vitamin Assay. New York. Interscience Publishers, 1947.
62. Abels, J. C., Gorham, A. T., Pack, G. T., and Rhoads, C. P.: Metabolic Studies in Patients with Cancer of the Gastro-Intestinal Tract; Plasma Vitamin A Levels in Patients with Malignant Neoplastic Disease, Particularly of the Gastro-Intestinal Tract. J. Clin. Invest., *20:* 749–764, 1941.
63. Youmans, J. B., Patton, E. W., Sutton, W. R., Stern, R., and Steinkamp, R.: Surveys of Nutrition of Populations; Vitamin A Nutrition of a Rural Population in Middle Tennessee Am. J. Pub. Health, *34:* 368–378, 1944.
64. Ruffin, J. M., Cayer, D., and Perlzweig, W. A.: The Relation Between the Clinical Picture of a Mild or Early Vitamin Deficiency and Laboratory Determinations of Vitamin Levels. Gastroenterology, *3:* 340–356, 1944.
65. Yarbrough, M. E. and Dann, W. J.: The Dark Adaptometer and Blood Vitamin A Measurements in a North Carolina Nutrition Survey. J. Nutrition, *22:* 597–607, 1941.
66. Bessey, O. A.: Personal communication, 1946.
67. Jolliffe, N.: Experiences in New York City Nutrition Clinics. A. P. H. A. Meeting, October 1947.
68. Harris, P. L., Hickman, K. C. D., Jensen, J. L., and Spies, T. D.: Survey of Blood Plasma Levels of Vitamin A, Carotene, Ascorbic Acid, and Tocopherols of Persons in an Area of Endemic Malnutrition. Am. J. Pub. Health, *36:* 155–160, 1946.
69. Anderson, R. K. and Milam, D. F.: Biomicroscopy of Eyes in Evaluation of Nutritional Status; Conjunctival Changes. J. Nutrition, *30:* 11–15, 1945.
70. Krause, R. F. and Pierce, H. B.: Blood Levels and Absorption of Vitamin A in Children with Keratosis Follicularis. J. Nutrition, *33:* 633–640, 1947.
71. Adamson, J. D., Jolliffe, N., Kruse, H. D., Lowry, O. H., Moore, P. E., Platt, B. S., Sebrell, W. H., Tice, J. W., Tisdall, F. F., Wilder, R. M., and Zamecnik, P. C.: Medical Survey of Nutrition in Newfoundland. Canad. Med. Assoc. J., *52:* 227–250, 1945.
72. Hsu, H. C.: Serum Carotinoids and Vitamin A in Chinese. Chinese Med. J., *61:* 238–243, 1943.
73. Popper, H.: Distribution of Vitamin A in Tissue as Vizualized by Fluorescence Microscopy. Physiol. Rev., *24:* 205–224, 1944.
74. Spector, S., McKhann, C. F., and Meserve, E. R.: Effects of Disease on Nutrition; Absorption, Storage, and Utilization of Vitamin A in the Presence of Disease. Am. J. Dis. Child., *66:* 376–395, 1943.
75. Aron, H. C. S., Craig, R. M., Farmer, C. J., Kendell, H. W., and Schwemlein, G. X.: Effect of Elevated Body Temperature on Plasma Vitamin A and Carotene. Proc. Soc. Exp. Biol. Med., *61:* 271–276, 1946.

76. Yudkin, J.: Nutritional Deficiency in the Pathogenesis of Disease. Brit. Med. J., *1:* 5–7, 1944.
77. Lewis, J. M., Bodansky, O., Lillienfeld, M. C. C., and Schneider, H.: Supplements of Vitamin A and of Carotene During Pregnancy; Their Effect on Levels of Vitamin A in Blood of Mother and of Newborn Infant. Am. J. Dis. Child., *73:* 143–150, 1947.
78. Foltz, E. E., Barborka, C. J., and Ivy, A. C.: Level of Vitamin B-Complex in Diet at Which Detectable Symptoms of Deficiency Occur in Man. Gastroenterology, *2:* 323–344, 1944.
79. Goodhart, R. S. and Sinclair, H. M.: The Estimation of Cocarboxylase (Vitamin B_1 Diphosphate Ester) in Blood. Biochem. J., *33:* 1099–1108, 1939.
— — and — —: Deficiency of Vitamin B_1 in Man as Determined by Blood Cocarboxylase. J. Biol. Chem., *132:* 11–21, 1940.
80. Bueding, E. and Wortis, H.: Stabilization and Determination of Pyruvic Acid in Blood. J. Biol. Chem., *133:* 585–591, 1940.
81. Friedemann, T. E., Haugen, G. E., and Kmieciak, T. C.: Pyruvic Acid; Level of Pyruvic and Lactic Acids, and Lactic-Pyruvic Ratio in Blood of Human Subjects. Effect of Food, Light, Muscular Activity and Anoxia at High Altitude. J. Biol. Chem., *157:* 673–689, 1945.
82. Stotz, E. and Bessey, O. A.: Blood Lactate-Pyruvate Relation and Its Use in Experimental Thiamine Deficiency in Pigeons. J. Biol. Chem., *143:* 625–631, 1942.
83. Goldsmith, G. A.: The Blood Lactate-Pyruvate Relationship in Various Physiologic and Pathologic States. Am. J. Med. Sci., *215:* 182–188, 1948.
84. Schultz, A. S., Atkin, L., and Frey, C. N.: Determination of Vitamin B_1 by Yeast Fermentation Method. Ind. Eng. Chem., Anal. Ed., *14:* 35–39, 1942.
85. Melnick, D. and Field, H., Jr.: Chemical Determination of Vitamin B_1. J. Biol. Chem., *127:* 505–514, 515–530, 531–540, 1939.
86. Hennessey, D. J. and Cerecedo, L. R.: Determination of Free and Phosphorylated Thiamin by a Modified Thiachrome Assay. J. Am. Chem. Soc., *61:* 179–183, 1939.
87. Perlzweig, W. A., Kamin, H., Gue, I., and Blalock, J. B.: Modification of Thiochrome Method for Rapid Determination of Thiamine in Urine. Arch. Biochem., *6:* 97–103, 1945.
88. Mason, H. L. and Williams, R. D.: Determination of Thiamine in Urine by the Thiochrome Method; Determination of the Blank. J. Biol. Chem., *146:* 589–594, 1942.
89. Najjar, V. A. and Ketron, K. C.: Improved Thiochrome Method for Determination of Thiamine in Urine. J. Biol. Chem., *152:* 579–584, 1944.
90. Mickelsen, O., Condiff, H., and Keys, A.: Determination of Thiamine in Urine by Means of Thiochrome Technique. J. Biol. Chem., *160:* 361–370, 1945.
91. Mickelsen, O., Caster, W. O., and Keys, A.: Statistical Evaluation of Thiamine and Pyramin Excretions of Normal Young Men on Controlled Intakes of Thiamine. J. Biol. Chem., *168:* 415–431, 1947.
92. Melnick, D.: Vitamin B_1 (Thiamine) Requirement of Man. J. Nutrition, *24:* 139–151, 1942.
93. Williams, R. D., Mason, H. L., and Wilder, R. M.: Minimum Daily Requirement of Thiamine of Man. J. Nutrition, *25:* 71–97, 1943.
Williams, R. D., Mason, H. L., Power, M. H., and Wilder, R. M.: Induced Thiamine (Vitamin B_1) Deficiency in Man; Relation of Depletion of Thiamine to Development of Biochemical Defect and of Polyneuropathy. Arch. Int. Med., *71:* 38–53, 1943.
94. Mason, H. L. and Williams, R. D.: Urinary Excretion of Thiamine as an Index of the Nutritional Level; Assessment of the Value of a Test Dose. J. Clin. Invest., *21:* 247–255, 1942.
95. Holt, L. E., Jr.: The Thiamine Requirement of Man. Fed. Proc., *3:* 171–178, 1944.
96. Denko, C. W., Grundy, W. E., Potter, J. W., and Berryman, G. H.: Excretion of B-Complex Vitamins in Urine and Feces of Seven Normal Adults. Arch. Biochem., *10:* 33–40, 1946.
97. Oldham, H. G., Davis, M. V., and Roberts, L. J.: Thiamine Excretions and Blood Levels of Young Women on Diets Containing Varying Levels of B Vitamins, With Some Observations on Niacin and Pantothenic Acid. J. Nutrition *32:* 163–180, 1946.
98. Gifft, H. H. and Hauck, H. M.: A Comparison of Four Methods for Studying the Urinary Excretion of Thiamine. J. Nutrition, *31:* 635–645, 1946.
99. Hulse, M. C., Weissman, N., Stotz, E., Clinton, M., and Ferrebee, J. W.: Subclinical

Vitamin Deficiency; Assay for Subclinical Thiamin Deficiency. Ann. Int. Med., *21:* 440–446, 1944.

100. Holt, L. E. Jr. and Najjar, V. A.: A Simple Method for the Laboratory Diagnosis of Subclinical Deficiencies of Thiamin, Riboflavin, and Nicotinic Acid. Bull. Johns Hopkins Hospital, *70:* 329, 1942.
101. Papageorge, E. and Lewis, G. T.: A Study of the Fasting-Hour Excretion of Thiamine in the Urine of Normal Subjects. J. Nutrition, *34:* 301–310, 1947.
102. Melnick, D. and Field, H., Jr.: Thiamine Clearance as an Index of Nutritional Status. J. Nutrition, *24:* 131–138, 1942.
103. Holt, L. E., Jr.: B Vitamins and Certain Problems They Present to the Practicing Physician. Penna. Med. J., *46:* 451–458, 1943.
104. Goldsmith, G. A. and Sarett, H. P.: Urinary Excretion of B Vitamins in Persons on Normal and Restricted Diets. Fed. Proc., *7:* 288, 1948.
105. Greenberg, L. D. and Rinehart, J. F.: Methods for Determination of Thiamine in Blood and Tissues, with Observations on Relative Contents. Proc. Soc. Exp. Biol. & Med., *59:* 9–13, 1945.
106. Hennessey, D. J.: Biological Symposia, Vol. XII, 86–120 B. Lancaster, Pa. The Jacques Cattell Press, 1947.
107. Keys, A., Henschel, A., Taylor, H. L., Michelsen, O., and Brozek J.: Experimental Studies on Man with Restricted Intake of B Vitamins. Am. J. Physiol., *144:* 5–42, 1945.
108. Snell, E. E. and Strong, F. M.: A Microbiological Assay for Riboflavin. Ind. Eng. Chem., Anal. Ed., *11:* 346–350, 1939.
109. Hodson, A. Z. and Norris, L. C.: Fluorimetric Method of Determining Riboflavin Content of Foodstuffs. J. Biol. Chem., *131:* 621–630, 1939.
110. Conner, R. T. and Straub, G. J.: Combined Determination of Riboflavin and Thiamin in Food Products. Ind. Eng. Chem., *Anal. Ed., 13:* 385–388, 1941.
111. Ferrebee, J. W.: Urinary Excretion of Riboflavin; Fluorimetric Methods for Its Estimation. J. Clin. Invest., *19:* 251–256, 1940.
112. Najjar, V. A.: Fluorimetric Determination of Riboflavin in Urine and Other Biological Fluids. J. Biol. Chem., *141:* 355–364, 1941.
113. Brewer, W., Porter, T., Ingalls, R., and Ohlson, M. A.: The Urinary Excretion of Riboflavin by College Women. J. Nutrition, *32:* 583–596, 1946.
114. Sarett, H. P. and Perlzweig, W. A.: The Effect of Protein and B-Vitamin Levels of Diet Upon Tissue Content and Balance of Riboflavin and Nicotinic Acid in Rats. J. Nutrition, *25:* 173–183, 1943.
115. Sarett, H. P., Klein, J. R., and Perlzweig, W. A.: The Effect of the Level of Protein Intake Upon the Urinary Excretion of Riboflavin and Nicotinic Acid in Dogs and Rats. J. Nutrition *24:* 295–306, 1942.
116. Perlzweig, W. A., Huff, J. W., and Gue, I.: The Excretion of Thiamin, Riboflavin, and Nicotinic Acid by Fasting Men. Fed. Proc., *3:* 62, 1944.
117. Sure, B. and Ford, Z. W., Jr.: Vitamin Interrelationships; Thiamine and Riboflavin Interrelationships in Metabolism. J. Biol. Chem., *146:* 241–250, 1942.
118. Davis, M. V., Oldham, H. G., and Roberts, L. J.: Riboflavin Excretions of Young Women on Diets Containing Varying Levels of the B Vitamins. J. Nutrition, *32:* 143–161, 1947.
119. Hagedorn, D. R., Kyhos, E. D., Germek, O. A., and Sevringhaus, E. L.: Observation on Riboflavin Excretion by Adult Male. J. Nutrition, *29:* 179–189, 1945.
120. Cogswell, R. C., Berryman, G. H., Henderson, C. R., Denko, C. W., and Spinella, J. R.: Absence of Rapid Deterioration in Moderately Active Young Men on a Restricted Intake of B-Complex Vitamins and Protein. Am. J. Physiol., *147:* 39–48, 1946.
121. Holt, L. E., Jr.: Exhibit, New York Academy of Medicine, Postgraduate Fortnight. October 1947.
122. Feder, V. H., Lewis, G. T., and Alden, H. S.: Studies on Urinary Excretion of Riboflavin. J. Nutrition, *27:* 347–353, 1944.
123. Hathaway, M. L. and Lobb, D. E.: Comparison of Riboflavin Synthesis and Excretion in Human Subjects on Synthetic and Natural Diets. J. Nutrition, *32:* 9–18, 1946.

124. Hou, H. C. and Dju, M. Y.: Riboflavin Deficiency Among Chinese; Urinary Excretion of Riboflavin. Chinese Med. J., *62:* 140–151, 1944.
125. Strong, F. M., Feeney, R. E., Moore, B., and Parsons, H. T.: The Riboflavin Content of Blood and Urine. J. Biol. Chem., *137:* 363–372, 1941.
126. Bradford, E. A. M. and Coke, H.: The Microbiological Determination of Riboflavin in Blood. Biochem. J., *39:* 379–385, 1945.
127. Axelrod, A. F., Spies, T. D., and Elvehjem, C. A.: The Riboflavin Content of Blood and Muscle in Normal and in Malnourished Humans. Proc. Soc. Exp. Biol. Med., *46:* 146–149, 1941.
128. Burch, H. B., Bessey, O. A. and Lowry, O. H.: Fluorometric Measurement of Riboflavin and its Natural Derivatives in Small Quantities of Blood Serum and Cells. J. Biol. Chem., *175:* 457–470, 1948.
129. Snell, E. E. and Wright, L. D.: A Microbiological Method for the Determination of Nicotinic Acid. J. Biol. Chem., *139:* 675–686, 1941.
130. Krehl, W. A., Strong, F. M., and Elvehjem, C. A.: Determination of Nicotinic Acid. Modifications in the Microbiological Method. Ind. Eng. Chem., Anal. Ed., *15:* 471–475, 1943.
131. Perlzweig, W. A., Levy, E. D., and Sarett, H. P.: Nicotinic Acid Derivatives in Human Urine and Their Determination. J. Biol. Chem., *136:* 729–745, 1940.
132. Melnick, D. and Field, H., Jr.: Determination of Nicotinic Acid in Biological Materials by Means of Photoelectric Colorimetry. J. Biol. Chem., *134:* 1–16, 1940.
Ibid., *135:* 53, 1940.
133. Najjar, V. A. and Wood, R. W.: The Presence of Hitherto Unrecognized Nicotinic Acid Derivative in Human Urine. Proc. Soc. Exp. Biol. Med., *44:* 386–390, 1940.
134. Huff, J. W. and Perlzweig, W. A.: A Rapid Method of Estimating N′-Methylnicotinamide in Urine. J. Biol. Chem., *150:* 483–484, 1943.
135. Huff, J. W., Perlzweig, W. A., and Tilden, M. W.: A Simple Method for the Determination of N′-Methylnicotinamide in Urine. Fed. Proc. *4:* 92–93, 1945.
136. Knox, W. E. and Grossman, W. I.: A New Metabolite of Nicotinamide. J. Biol. Chem., *166:* 391–392, 1946.
137. Knox, W. E.: Identification of New Metabolites of Nicotinic Acid. A. A. A. S. Conference. New London, New Hampshire. 1947.
138. Rosen, F., Perlzweig, W. A., and Handler, P.: A Fluorometric Assay for N′Methyl-6-Pyridone-3-Carboxylamide. Fed. Proc. *7:* 181, 1948.
139. Klein, J. R., Perlzweig, W. A., and Handler, P.: The Determination of Nicotinic Acid in Blood Cells and Plasma. J. Biol. Chem., *145:* 27–34, 1942.
140. Carter, C. W. and O'Brien, J. R. P.: The Nicotinic Acid Content of Blood in Health and Disease. Quart. J. Med., *14:* 197–205, 1945.
141. Axelrod, A. E., Gordon, E. S., and Elvehjem, C. A.: The Relationship of Dietary Intake of Nicotinic Acid to Coenzyme I Content of Blood. Am. J. Med. Sci., *199:* 697–705, 1940.
142. Kohn, H. I. and Bernheim, F.: Blood V-Factor (Coenzyme) in Normal and Pathoiogical Subjects. J. Clin. Invest., *18:* 585–591, 1939.
143. Youmans, J. B. and Patton, E. W.: Laboratory Diagnosis of Nutritional Deficiencies. Clinics, *1:* 303–345, 1942.
144. Vilter, R. W., Vilter, S. P., and Spies, T. D.: The Relationship Between Nicotinic Acid and Codehydrogenase (Cozymase) in Blood of Pellagrins and Normal Persons. J. A. M. A., *112:* 420–422, 1939.
145. Perlzweig, W. A., Sarett, H. P., and Margolis, L. H.: Studies in Nicotinic Acid Metabolism; A Test for Nicotinic Acid Deficiency in Man. J. A. M. A., *118:* 28–30, 1942.
146. Goldsmith, G. A.: Urinary Excretion of Nicotinic Acid and Its Derivatives. Arch. Int. Med., *73:* 410–414, 1944.
147. Field, H., Jr., Melnick, D., Robinson, W. D., and Wilkinson, C. F., Jr.: Studies on Chemical Diagnosis of Pellagra (Nicotinic Acid Deficiency). J. Clin. Invest., *20:* 379–386, 1941.
148. Coulson, R. A., Ellinger, P., and Smart, G. A.: Urinary Elimination of Nicotinamide Methochloride in Subjects with Normal Gums and with Acute and Chronic Gingivitis. Brit. Med. J., *1:* 6–8, 1945.
149. Sarett, H. P., Huff, J. W., and Perlzweig, W. A.: Studies in Nicotinic Acid Metabolism; The Fate of Nicotinic Acid in Man. J. Nutrition, *23:* 23–34, 1942.

150. Mickelsen, O. and Erickson, L. L.: The F_2 Excretion of Normal Men on Different Levels of Niacin Intake. Proc. Soc. Exp. Biol. Med., *58:* 33–36, 1945.

151. Sargent, F., Robinson, P. F., and Johnson, R. E.: F_1 and F_2 of Najjar and Holt in Urine of Normal Young Men. J. Clin. Invest., *23:* 714–719, 1944.

152. Najjar, V. A. and Holt, L. E. Jr.: Excretion of Specific Fluorescent Substances in Urine in Pellagra. Science, *93:* 20–21, 1941.

Najjar, V. A.: Laboratory Diagnosis of Nicotinic Acid Deficiency; Improved Procedure for Determination of F_2 (N-Methyl Nicotinamide Derivative) in Urine. Bull. Johns Hopkins Hospital, *74:* 392–399, 1944.

Najjar, V. A., Stein, H. J., Holt, L. E., Jr., and Kabler, C. V.: The Excretion of Specific Fluorescent Substances in Urine in Experimental Nicotinic Acid Deficiency. J. Clin. Invest., *21:* 263–267, 1942.

153. Cayer, D. and Cody, S.: The Nutritional State of Patients with Peptic Ulcer as Measured by Vitamin Levels in the Blood and Urine. Gastroenterology, *9:* 54–63, 1947.

154. Holt, L. E., Jr. and Najjar, V. A.: A Simple Method for the Laboratory Diagnosis of Subclinical Deficiencies of Thiamin, Riboflavin, and Nicotinic Acid. Fed. Proc., *1:* 117, 1942; Journal-Lancet, *63:* 366–371, 1943.

155. Sarett, H. P. and Goldsmith, G. A.: Effect of Tryptophane on Excretion of Nicotinic Acid Derivatives in Humans. J. Biol. Chem., *167:* 293–294, 1947.

156. Perlzweig, W. A., Rosen, F., Levitas, N., and Robinson, J.: Excretion of Nicotinic Acid Derivatives After Ingestion of Tryptophane by Man. J. Biol. Chem., *167:* 511–514, 1947.

157. Sarett, H. P. and Goldsmith, G. A.: Tryptophane and Nicotinic Acid Studies in Man. J. Biol. Chem., *177:* 461–475, 1949.

158. Tillmans, J., Hirsch, P., and Vaubel, R.: Reducing Capacity of Plant Foods in Relation to Vitamin C. 6. Preparation of Pure Reducing Substance from Rose Hips and Its Identity with Vitamin C. Ztschr. Untersuch. Lebensmitt., *65:* 145–167, 1933.

159. Harris, L. J. and Ray, S. N.: Specificity of Hexuronic (Ascorbic) Acid as an Antiscorbutic Factor. Biochem. J., *27:* 580–589, 1933.

160. Bessey, O. A. and King, C. G.: The Distribution of Vitamin C in Plant and Animal Tissues, and Its Determination. J. Biol. Chem., *103:* 687–698, 1933.

161. Farmer, C. J. and Abt, A. F.: Determination of Ascorbic Acid in Small Amounts of Blood. Proc. Soc. Exp. Biol. Med., *34:* 146–150, 1936.

162. Bessey, O. A.: A Method for the Determination of Small Quantities of Ascorbic Acid and Dehydroascorbic Acid in Turbid and Colored Solutions in the Presence of Other Reducing Substances. J. Biol. Chem., *126:* 771–784, 1938.

163. Mindlin, R. L. and Butler, A. M.: Determination of Ascorbic Acid in Plasma; Macromethod and Micromethod. J. Biol. Chem., *122:* 673–686, 1937–38.

164. Robinson, W. B. and Stotz, E.: The Indophenolxylene Method for Ascorbic Acid and Modifications for Interfering Substances. J. Biol. Chem., *160:* 217–225, 1945.

165. Butler, A. M., Cushman, M., and MacLachlan, E. A.: Determination of Ascorbic Acid in Whole Blood and Its Constituents by Means of Methylene Blue; Macro- and Micromethods. J. Biol. Chem., *150:* 453–461, 1943.

166. Roe, J. H. and Oesterling, M. J.: Determination of Dehydroascorbic Acid and Ascorbic Acid in Plant Tissues by 2,4-Dinitrophenylhydrazine Method. J. Biol. Chem., *152:* 511–517, 1944.

167. Bessey, O. A., Lowry, O. H., and Brock, M. J.: Quantitative Determination of Ascorbic Acid in Small Amounts of White Blood Cells and Platelets. J. Biol. Chem., *168:* 197–205, 1947.

168. Thysell, T.: Diet, Blood Ascorbic Acid, and the Capillary Resistance Test. Acta Paediat., *26:* 481–488, 1939.

169. Farmer, C. J.: Some Aspects of Vitamin C Metabolism. Fed. Proc., *3:* 179–188, 1944.

170. Haines, J. E., Klosterman, A. M., Hauck, H. M., Delaney, M. A., and Kline, A. B.: Tissue Reserves of Ascorbic Acid in Normal Adults on Three Levels of Intake. J. Nutrition, *33:* 479–489, 1947.

171. Oldham, H., Roberts, L. J., and Young, M.: Results of Providing a Liberally Adequate Diet

to Children in an Institution; Blood and Urinary Excretion Studies Before and After Improvement. J. Pediat. *27:* 418–427, 1945.

172. Kruse, H. D.: A Concept of the Deficiency States. Milbank Mem. Fund Quart., *20:* 245–261, 1942.
173. Dodds, M. L. and MacLeod, F. L.: Blood Plasma Ascorbic Acid Levels on Controlled Intakes of Ascorbic Acid. Science, *106:* 67, 1947.
174. Present Knowledge of Ascorbic Acid (Vitamin C) in Nutrition. Nutrition Rev., *4:* 259–262, 1946.
175. Johnson, R. E., Darling, R. C., Sargent, F., and Robinson, P.: Effects of Variations in Dietary Vitamin C on Physical Well Being of Manual Workers. J. Nutrition, *29:* 155–165, 1945.
176. Crandon, J. H., Lund, C. C., and Dill, D. B.: Experimental Human Scurvy. New England J. Med., *223:* 353–369, 1940.
177. Lowry, O. H., Bessey, O. A., Brock, M. J., and Lopez, J. A.: Interrelationship of Dietary, Serum, White Blood Cell, and Total Body Ascorbic Acid. J. Biol. Chem., *166:* 111–119, 1946.
178. Linghorne, W. J., McIntosh, W. G., Tice, J. W., Tisdall, F. F., McCreary, J. F., Drake, T. G. H., Greaves, A. V., and Johnstone, W. M.: Relation of Ascorbic Acid Intake to Gingivitis. Canad. Med. Assoc. J., *54:* 106–119, 1946.
179. Dogramaci, I.: Scurvy; A Survey of 241 Cases. New England J. Med., *235:* 185–189, 1946.
180. Vilter, R. W., Woolford, R. M., and Spies, T. D.: Severe Scurvy; Clinical and Hematological Study. J. Lab. Clin. Med., *31:* 609–630, 1946.
181. McMillan, R. B. and Inglis, J. C.: Scurvy; A Survey of 53 Cases. Brit, Med. J., *2:* 233–236, 1944.
182. Johnstone, W. M., Drake, T. G. H., Tisdall, F. F., and Harvie, F. H.: A Study of Ascorbic Acid Metabolism of Healthy Young Canadians. Canad. Med. Assoc. J., *55:* 581–585, 1946.
183. Milam, D. F. and Wilkins, W.: Vitamin C in Normal Nutrition; The Effect of Low-Cost Diet on Plasma Levels Over a 6-Weeks Period. South. Med. & Surg. J., *104:* 191, 1942.
184. Munks, B., Kaucher, M., Moyer, E., Harris, M. E., and Macy, I. G.: Metabolism of Women During the Reproductive Cycle. XI. Vitamin C in Diets, Breast Milk, Blood, and Urine of Nursing Mothers. J. Nutrition, *33:* 601–619, 1947.
185. Smith, C. and Stuart, H.: Appraising the Nutritional Status of Mothers and Infants. A. P.-H. A. Meeting. October 1947.
186. McNee, G. Z. L. and Reid, J.: Vitamin C Nutrition in the Royal Navy and in a Section of Civilian Population During War-Time. Lancet, *2:* 538–540, 1942.
187. Walsh, G. E. K.: Vitamin C Levels in a Prisoner of War Camp. Brit. Dental J., *79:* 208–210, 1945.
188. Anderson, R. K., Calvo de la Torre, J., Serrano, G., and Payne, G. C.: A Study of the Nutritional Status and Food Habits of Otomi Indians in the Mezquital Valley of Mexico. Am. J. Pub. Health, *36:* 883–903, 1946.
189. Leeson, H. J., Webb, J. F., Ferguson, H. P., Semmons, E. M., and McHenry, E. W.: Study of Ascorbic Acid Nutrition. Canad. Med. Assoc. J., *53:* 341–344, 1945.
190. Youmans, J. B., Patton, E. W., Sutton, W. R., Kern, R., and Steinkamp, R.: Surveys of Nutrition of Populations; Vitamin C Nutrition of a Rural Population in Middle Tennessee. J. Hygiene, *42:* 254–261, 1945.
191. Kyhos, E. D., Gordon, E. S., Kimble, M. S., and Sevringhaus, E. L.: Minimum Ascorbic Acid Needs of Adults. J. Nutrition, *27:* 271–285, 1944.
192. Smith, S. L.: Human Requirements of Vitamin C. J. A. M. A., *111:* 1753–1764, 1938.
193. Holland, A. H., Jr., Canniff, J. C., and Bruger, M.: Evaluation of Vitamin C Status of Human Subjects; Studies with Intradermal Dye Discoloration, Capillary Fragility, Fasting Plasma Vitamin C Level, and Vitamin C Saturation. J. Lab. & Clin. Med., *32:* 124–129, 1947.
194. Wright, I. and Ludden, J. B.: Treatment with Vitamin C (Cevitamic Acid—Ascorbic Acid); A Method for Compensating for the Factor of Error Due to Renal Retention of Vitamin C

Found in All Previous Saturation and Blood Tests. Med. Clin. North America, *24:* 743–758, 1940.

195. Kajdi, L., Light, J., and Kajdi, C.: Test for Determination of Vitamin C Storage; Vitamin C Index. J. Pediat., *15:* 197–218, 1939.
196. Bodansky, A.: Phosphatase Studies; Determination of Serum Phosphatase. Factors Influencing Accuracy of Determination. J. Biol. Chem., *101:* 93–104, 1933.
— —: Notes on Determination of Serum Inorganic Phosphatase and Serum Phosphatase Activity. Am. J. Clin. Path., Tech. Suppl., *1:* 51–59, 1937.
197. Bessey, O. A., Lowry, O. H., and Brock, M. J.: A Method for the Rapid Determination of Alkaline Phosphatase with Five Cubic Millimeters of Serum. J. Biol. Chem., *164:* 321–329, 1946.
198. Klasmer, R.: Serum Phosphatase Activity and Clinical Rickets in Children in Jerusalem. Am. J. Dis. Child., *67:* 348–354, 1944.
199. Bodansky, A. and Jaffe, H. L.: Phosphatase Studies: Serum Phosphatase as a Criterion of Severity and Rate of Healing of Rickets. Am. J. Dis. Child., *48:* 1268–1278, 1934.
— —, — —: Serum Phosphatase in Diseases of the Bone: Interpretation and Significance. Arch. Int. Med., *54:* 88–110, 1934.
200. Youmans, J. B., Patton, E. W., Sutton, W. R., Kern, R., and Steinkamp, R.: Surveys of Nutrition of Populations. IV. Vitamin D and Calcium Nutrition of a Rural Population in Middle Tennessee. Am. J. Pub. Health, *34:* 1049–1057, 1944.
201. Bessey, O. A.: To be published.
202. Macy, Icie G.: Nutrition and Chemical Growth in Childhood. Vol. I, p. 212, 314, 316. Springfield, Illinois. Charles C. Thomas, 1946.
203. Kolmer, J. A.: Clinical Diagnosis by Laboratory Examinations. First Ed. Rev., p. 132. New York. D. Appleton Co., 1944.
204. Howland, J. and Kramer, B.: Calcium and Phosphorus in the Serum in Relation to Rickets. Am. J. Dis. Child., *22:* 105–119, 1921.
205. Gamble, J. L.: Chemical Anatomy, Physiology and Pathology of Extra-Cellular Fluid. Fourth Edition. Cambridge, Mass. Harvard Medical School, 1942.
206. Keys, Ancel: Physical Performance in Relation to Diet. Fed. Proc., *2:* 164–187, 1943.
207. Dill, D. B.: Life, Heat and Altitude. Harvard University Press, 1938.
208. Marriott, H. L.: Water and Salt Depletion (Croonian Lectures). Brit. Med. J., *1:* 245, 285, 328, 1947.
209. Talbott, J. H.: Heat Cramps. Medicine, *14:* 323–376, 1935.

APPENDIX

Tests which may be useful in nutrition surveys:

1. Serum Proteins
   Micro Kjeldahl-titration or nesslerization (29)
   Specific gravity-copper sulphate (9), falling drop (7), micromethod (10)
2. Hemoglobin and Iron
   Oxyhemoglobin-macromethod (27) or micromethod (3), alkaline hematin (28) copper sulphate (9)
   Serum Iron (32)
3. Vitamin A in Blood
   Macromethods-Carr Price reaction (55) (56) (57) (58)
   Micromethod (59)
4. Thiamine in Urine
   One-hour fasting excretion and load tests (oral or parenteral)
   Thiochrome procedure (86) (87) (88)
   Pyramin and thiamine determination (90)
5. Riboflavin
   a) Urinary excretion—One-hour fasting and load tests (oral or parenteral)
      Microbiological method (108)

Fluorometric procedures (109) (110)
Direct fluorometric method after load tests (111) (6)
b) In erythrocytes (3) (128)

6. Niacin
One-hour fasting excretion and load tests
Determination of N'methyl nicotinamide (133) (134) (135)

7. Ascorbic Acid
In blood-plasma and leukocytes
Macromethods (162) (163) (164) (165) (166)
Micromethod (167)
One-hour fasting urinary excretion (50) (52)
Load test-estimation of blood concentration (195)
Load tests-urinary excretion-oral test dose (2) (175) (169), parenteral test dose (194)

8. Vitamin D
Phosphatase
Macromethod (196)
Micromethod (197)

Section IV

CLINICAL DIAGNOSIS IN NUTRITION SURVEYS

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INTRODUCTION

In the past, clinical examination during nutrition surveys has paid special attention to symptoms and signs commonly seen in individuals with known classical primary deficiency disease due to inadequate intake of food or nutrients. In addition, many examiners have looked for less obvious clinical stigmata which have been suggested by some observers as being nutritional in origin, and for signs produced by experimentally induced deficiencies.

During surveys, diagnosis of well-developed specific nutritional disease by physical examination alone is not a difficult procedure for physicians who have had experience in this field, especially if they are vigilant. Similarly, recognition of the numerous individual stigmata of so-called "sub-clinical nutritional deficiency syndromes" comes easily to those physicians who have seen them previously. The difficulty which exists is to be able to recognize that the stigmata which have been noted are due to nutritional deficiency of any cause, without further study of the individual.

A decade ago when many of the stigmata were first systematically studied (26, 27, 28, 29, 34, 40), it was hoped that they would be specific enough to allow physicians, or even specially trained nutritionists who were not qualified medically, to make an exact and unequivocal diagnosis of specific deficiency states without difficulty. Unhappily, numerous investigations have not realized this hope and current opinion of the value of special examination for the stigmata is well summarized by Adamson and his ten colleagues (1), who state:

"At the present time there is a diversity of opinion as to the specificity of many of the lesions here described. In other words, while it is generally recognized that nutritional inadequacies will produce most of them, some observers believe that some of them may also be produced by other means. Furthermore, some of the authors consider that even when the signs and symptoms are proved signs of nutritional ill-

health, they may not be so specific in their etiological relationship as is implied in the following presentation."

As pointed out above, it is not easy to recognize early nutritional deficiency disease by simple inspection. Even well-developed nutritional diseases cannot always be diagnosed at a glance. For example, in his book on "Clinical Pellagra" Seale Harris (13) points out that "Pellagra may be confused with sprue, pernicious anemia, tuberculous enteritis, chronic pancreatitis, gastrogenic diarrhea and stomatitis from different causes" while Swanson (39) in a discussion of the differential diagnosis of the skin in advanced pellagra states:

"The following diseases often have skin manifestations that resemble the eruption of pellagra: acrodynia, erythema solare, erythema caloricum, erythema pernio, erythema multiforme, eczema, especially the erythematous form, dermatitis venenata, 'recurrent summer eruption', lupus, syphilis, xerodermia, erysipeloid, erysipelas."

From the onset, then, the view is presented here that there is no such thing as a single pathognomonic sign, that interpretation of clinical findings in a given individual requires careful differential diagnosis, including history, physical examination, and laboratory findings, and that in many instances a therapeutic diagnosis is necessary to settle clinical judgments.

These views are succinctly presented by Jolliffee (19) with his wealth of experience from nutrition surveys and from the clinic:

"In connection with the signs of malnutrition, it is necessary to emphasize four important points. The first is that, with but few exceptions, the signs are nonspecific and may be produced by trauma other than malnutrition. No single sign of malnutrition is necessarily diagnostic; each must be evaluated in light of the history, and other signs and symptoms. Other possible causes must be ruled out. Interpretation of these signs requires all the diagnostic acumen and clinical judgment required in other branches of internal medicine."

In addition to the excerpts quoted above, the published opinions of many authors (e.g., 14, 31) make it clear that differential diagnosis is an essential part of physical examination during nutrition surveys. It should be noted that accurate differential diagnosis is difficult to accomplish when single signs or stigmata are found in a patient during a survey. Such being the case, interpretations of positive findings should only be made by physicians or dentists and not by unqualified persons. Differential diagnosis must include a consideration and knowledge of at least eleven classes of etiology. These are: congenital and hereditary; deficiency of oxygen and nutrients; parasites; trauma, including the effects of the environment; physical irritants; chemical poisons; tumors; degenerations; endocrine and metabolic; and unknown. An example of a physical sign which requires differential diagnosis when it is observed is purpura, which may have any of the above etiologies, including nutritional. In passing it should be noted that few studies have been made of the frequency distributions or incidence of the different lesions or stigmata mentioned above among normal population groups. Such data are urgently needed.

ELICITING HISTORIES OF NUTRITIONAL DISTURBANCES DURING SURVEYS

When nutritional deficiency exists it is usual to find that, as with other disease processes, some symptoms occur before physical signs appear. Moreover, spontane-

ous complaints of disturbed functions and of bodily and mental distress are of great value, for in the clinic more often than not it is the patient's story which confirms a diagnosis of deficiency disease. It is unfortunate that the process of obtaining a history takes such a long time. This is the main reason why the elucidation of symptoms is not more frequently used as a tool during nutrition surveys.

The questionnaire method of collecting data is not of much value. In addition to its other limitations, it is not flexible enough to use in clinical examinations. For example, a positive reply to the question, "Do you have diarrhea?" does not differentiate between the thin, burning looseness of pellagra, the copious stools of celiac disease, or the urgent bloody flux of dysentery.

Many of the symptoms of deficiency syndromes and disturbances are striking: the distressing and painful crying of a scorbutic infant, even in its mother's arms; the excessive spittle flowing in the mouth of the pellagrin; the sore tongue and burning mouth of those suffering with nicotinic acid deficiency, pernicious anemia or sprue; the difficulty with swallowing discovered in those patients who have the Plummer-Vinson syndrome; the pins and needles and hot burning feet of thiamine deficiency, and the word gaps which disturb the reading of those with nutritional scotomata, are unusual enough to catch the attention of the physician. Unfortunately, each of the symptom complexes mentioned above can arise as a result of disease processes which apparently do not have a nutritional origin. Pyogenic joint infections in babies are also distressingly painful; many patients with peptic ulcer complain of water-brash; difficulty with swallowing occurs in esophageal cancer; and pins and needles and burning of the feet are common symptoms of peripheral vascular disease and pernicious anemia.

Vital and striking complaints as described above are useful, for they facilitate diagnosis. Diagnosis is difficult when patients present few or no physical signs and complain of vague disturbances such as insomnia, loss of appetite, fatigue, weakness, palpitations, irritability, lack of ambition, and vague fears. These symptoms are classical early complaints in patients suffering with nutritional deficiency. They are also the common somatic and mental symptoms which arise with worry, anxiety, and difficult or unhappy situations in life. They may be the prodromal disturbances of serious physical and mental diseases such as tuberculosis, adrenal insufficiency, or depressive psychosis. In the clinic one cannot dismiss such patients without a long and thorough interview, a thorough physical examination, and further screening by means of laboratory examinations such as X-rays of the chest or blood sodium levels.

Thus, diagnosis is often not arrived at till days or weeks of watchful observation have passed. When such patients in the general medical clinic do in truth have a nutritional deficiency, the diagnosis is often not in hand till therapeutic diagnostic trials have been made. It is therefore obvious that symptoms such as described above, when discovered in populations, should not be accepted as *prima facie* evidence of malnutrition.

Nevertheless, despite all the difficulties cited above, histories should be obtained whenever possible during nutritional surveys. The length and detail of the history should only be limited by the time available to the surveyors. Surveys in foreign

lands require at best a working knowledge of the language and at worst the services of an interpreter.

SYMPTOMS OF EARLY DEFICIENCY STATES

With both adults and children questions should be designed to discover, especially, abnormalities of growth, malfunction of the gastro-intestinal system, disturbed psyche, and ocular or visual imperfections. In addition the physician should make an effort to determine if physiological or pathological stresses are present in the group or individual under study, and to gauge the extent to which these stresses may complicate malnutrition in the group or individual.

In children and infants lack of appetite, failure to eat, failure to gain weight, retarded muscular and mental development, aversion to play, poor sleeping habits, apathy, easy bruising, and chronic diarrhea or constipation are common maternal complaints when malnutrition exists. In adults, lack of appetite, nausea especially in the morning, soreness of the lips, tongue, mouth, vagina or anus, itching or sandiness of the eyeball, lacrimation and photophobia, lassitude, fatigue, insomnia, weakness, loss of energy, emotional upsets, paresthesia of the hands, feet, or tongue, disturbed bowel function, transient edema after daily activities, easy bruising, all are symptoms which may point to a diagnosis of malnutrition.

CONDITIONING FACTORS IN SURVEYS

Physiological stresses and pathological processes (7, 17) considerably modify nutritional requirements and may adversely affect nutrition. Moreover, during surveys it is not unusual to find multiple stresses acting together to initiate or exacerbate disorders based on malnutrition (21). Common pathological conditions such as malaria, hookworm and pinworm infestation, infective hepatitis, peptic ulcer, tuberculosis, chronic diarrhea, cancer, lack of teeth, as well as other diseases, may profoundly affect nutrition. The demands of growth, the menarche, pregnancy (especially repeated pregnancy), lactation, excessive menstrual flow, heavy muscular activity, extremes of climate, religious food taboos, alcoholism, psychic disturbances, and exposure to industrial toxins, among others, may precipitate nutritional disease.

These considerations are of great importance when surveys are contemplated on special population groups, such as workers in different industries, people in homes for the aged, nurses in metropolitan hospitals, prison populations, orphans in institutions, and tribal groups.

In the planning of surveys and in the interpretation of findings, conditioning factors must always be borne in mind and the incidence and extent of the different stresses which tend to depress good nutritional status must be determined by observation and investigation of the environment in which the population under study lives, and by appropriate questions and observation of the individual.

PHYSICAL EXAMINATIONS IN NUTRITION STUDIES

All attributes of man may be expressed in distribution curves, and this method of expressing the variations in standard and malnourished populations should be more

widely employed in future nutrition surveys. It is an unfortunate fact that distribution curves for individual signs of deficiency states, by sex, age, race, and environment in relation to any one sign, are almost non-existent. Even height-weight data are sparse. As good examples of the type of data which should be collected on

TABLE 1

SUGGESTED MINIMUM OBSERVATIONS TO BE REPORTED IN PUBLIC HEALTH NUTRITION SURVEYS

TYPE OF OBSERVATION	DATA TO BE RECORDED
1. Dietary History	Report of actual foods consumed. If possible some quantitative estimate should be made. Calculation of nutrient intake if desired.
2. Medical History	Environmental conditions. Relevant spontaneous complaints. If possible, conditioning factors and elicited symptoms.
3. Physical Examination	(A) Place Date Age Sex Body height Body weight (in minimum clothing, which is described) Race (White, black, red, brown, yellow, if mixed, describe) Religious group (B) If more detailed physical examinations are conducted a check list may be used for recording findings by grade. This check list should have space for recording certain physical findings which are of importance in helping the examiner to make a correct diagnosis, even though these physical findings are p tently due to processes not nutritional in origin. Signs should not be listed with an etiological nomenclature. For instance acne rosacea has no etiologic connotation whereas seborrheic dermatitis of ariboflavinosis does. In the present state of knowledge etiologic nomenclature is likely to be misleading.
4. Laboratory	Whole blood hemoglobin and plasma protein by a specific gravity method. Blood smear. Clinical urinalysis, especially acetone, sugar and protein.
5. Diagnoses	Non-nutritional as well as nutritional disorders should be listed.

populations we commend for attention Bean's studies of telangiectasia (3), and Stewart and Manning's study (35) of the variations in the electrocardiogram of 500 normal young men.

In interpreting results obtained from nutrition surveys, statistical analysis of data should be made with more frequency than heretofore. In passing, the following statistical facts of great importance for interpreting results of surveys of large

numbers should be recalled: (a) that when a sign occurs in very low incidence normally, a small increase is significant; (b) that, contrariwise, when a given sign occurs normally with some frequency, a large increase is required for statistical significance.

In future surveys greater attention should be paid to the rigorous employment of differential diagnosis. This may be difficult even when studying an individual and is further complicated in any population group by prevalent disease (e.g. tuberculosis in American Indians; malaria in the tropics; hookworm in some of the southern states), by environmental stresses (e.g., effects of altitude on the Peruvians), and by factors of personal hygiene (e.g., non-bathing in cold climates). Nutrition surveys should include these considerations. Since the normal can only be recognized by comparison with the abnormal and as differential diagnosis of abnormal physical signs can only be unravelled by those who are trained in this skill, physicians should be included in any nutrition survey team.

TABLE 2

PHYSICAL EXAMINATIONS: SOME SIGNS OFTEN ATTRIBUTED TO NUTRITIONAL DISTURBANCES. AFTER JOLLIFFE AND MOST (20)

ORGANS	SIGN
Eyes	Conjunctivitis, dryness, photophobia, lachrymation, Bitot's spots, pterygia, scleral thickening, corneal cloudiness, obvious corneal vascularization.
Mouth, Tongue and Teeth	Cheilosis, glossitis, stomatitis, gingivitis, poor oral hygiene, angular fissure in absence of false teeth, fluorosis.
Skin	Petechial hemorrhages, purpura, symmetrical dermatitis, follicular hyperkeratosis, acneiform eruption, facial seborrhea.
Extremities	Muscular weakness, tenderness and atrophy, nerve tenderness, loss of vibratory sense, loss of tendon reflexes, edema.

Standardization of survey methods has worked well for the physical scientists and especially for the astronomers, who for 300 years have all made star maps according to internationally agreed criteria. The U. S. Bureau of Standards, for example, provides certain reference chemicals which most analytical chemists use. Therefore, in order to provide comparable data in the field of nutrition which can be read critically by any competent surveyor, a plea is made for standardization.

When public health nutrition surveys by individuals or teams are contemplated, consideration should be given to the value of this concept, and plans should be made to use techniques of a standard nature. Table 1 lists suggestions for minimal observations in public health nutrition surveys.

Uniform criteria and definitions of the many physical signs sought for during nutrition surveys are not available at present. In the meanwhile, it is suggested that the reader consult the Food and Nutrition Board publication, "Handbook on Clinical Diagnosis of Deficiency States" (in press) which contains a large number of photographs and detailed descriptions of lesions. Appendix A presents a suggested

check list for recording of physical findings. It should not be employed as a substitute for a thorough physical examination. A list of clinical publications on some important diseases and syndromes of nutritional origin spontaneously occurring in man will be found in Appendix B.

Study of clinical descriptions of these conditions in text books and elsewhere, and observations when possible in the clinic and hospital, will assist in making accurate diagnosis during a survey. In the proposed check list special attention has been paid to lesions of the skin, of the lips and mouth, and of the neuro-muscular system, because physical signs of nutritional disturbance appear early in these organs, as shown in Table 2 which is extracted from an article by Jolliffe and Most (20).

In infants and children, disturbances of growth are important physical signs of nutritional inadequacy, and where possible anthropomorphic data should be recorded by the Wetzel grid (41) or through simple techniques as described by Stuart and Meredith (36, 37, 38).

In both children and adults, various clinical laboratory tests such as X-rays of the bones for detecting disturbances of calcium metabolism, vitamin D deficiency and scurvy, fluoroscopy of the small bowel for abnormal activity and pattern, and other examinations such as electrocardiograms, measurement of venous pressure and circulation time, can be made at the discretion of the surveyors.

PHYSICAL SIGNS AND BIOCHEMICAL MEASUREMENTS IN NUTRITION SURVEYS

In an attempt to measure quantitatively nutritional disease processes, biochemical analyses have been made of the excreta, the blood cells, the body fluids and the body tissues. These have been made during the fasting state, before and after load tests or other therapeutic measures, and have included measurements of minerals, vitamins, fats, carbohydrates, and proteins, their metabolic derivatives, and normal and abnormal products of metabolic reactions in which nutrients take a part. Measurements of hemoglobin, blood prothrombin, alkaline phosphatase, blood calcium, serum albumen, and ketone bodies are accepted by most workers as indices of nutritional adequacy or inadequacy, *when properly interpreted in the light of clinical findings and other biochemical measurements*. For example, alterations of hemoglobin levels in a population may be due to chronic malaria, helminthiasis, lead poisoning, sojourn at high altitudes, dehydration, muscular activity, or inadequate nutrition. Interpretation of hemoglobin levels in any population therefore requires a discerning analysis in the light of other findings. These have been discussed in some detail in the section on biochemistry, in the present publication. The present paragraphs are therefore devoted to a discussion of the correlations and non-correlations between physical signs and biochemical data.

During the war, nutrition surveys by biochemical and clinical methods were made on soldiers all over the world, and in most instances a lack of correlation was found between individual clinical stigmata as listed in Table 2 and biochemical measurements of nutrients. The reasons for this lack of correlation were discussed in a study of over 1600 soldiers in the tropics (23) which states:

"The few correlations between individual clinical stigmata and biochemical measurements were between small average differences; their physiological interpretation

was not apparent and they could not be used for diagnostic purposes in individual cases. A different set of results might be expected in a population suffering from florid nutritional disease. Lack of correlation between biochemical and clinical findings has been reported by Milam and Anderson (1944) in North Carolina, by Riggs et al (1943) in Canada, and by Youmans et al (1942) (1943) in Tennessee, and some of the many possible contributing causes for this situation have been discussed by Sinclair (1944) and by Dann and Darby (1945). In a well-controlled laboratory experiment, imposition of a deficiency diet is followed in order by chemical unsaturation of the tissues, by impairment of functions without histological changes, and finally by definite pathological changes in the tissues. In natural environments the interpretation of changes is difficult. A subject previously unsaturated may have had recent access to nutrients enough to raise his tissue concentration without restoring function or reversing pathological changes. Again, disturbance of nutrition is only one of many possible causes of functional impairment. Finally, a given pathological change, such as cheilosis, may result from one or many processes other than nutritional deficiency (Machella, 1942; Machella and McDonald, 1943). Pott (1945) has emphasized another phase of the lack of correlation among chemistry, function and pathology. Many characteristics of a population can be expressed in distribution curves. An individual subject provides a single point on each curve but there is no valid reason to expect that measurements on him will always fall in the same portion of every curve. For instance, there should be no occasion for surprise that a man should be classified as having a high degree of fitness and yet as having a low serum ascorbic acid and at the same time normal optic discs. Since it is excessively uncommon for a single type of observation to be diagnostic for any specific disease, extreme caution should be used in interpreting data on the lower end of distribution curves. So far as nutrition is concerned, it may be that a whole population is so well fed that even those whose measurements are on the lower ends of the distribution curve are by any reasonable standard not at all deficient, and this is the exact interpretation we place on the data for U. S. troops in the Pacific. In contrast, some of the distribution curves for the Indian troops had lower values than those of U. S. troops and there were in Burma actual cases of ill health associated with positive clinical findings and poor biochemical states."

Observations such as the foregoing have led us to believe that at present the evaluation of nutritional status by biochemical measurements made on a single occasion may give good results, but only when interpreted as one part of a detailed clinical study of an individual. When applied to generally healthy population groups such as soldiers, biochemical observations made on a single occasion will be useful but only as a check on recent dietary intake (6). They will not provide a valid measure of sub-clinical deficiency, unless repeated enough times to show whether the population under study is remaining static or is going up or down with respect to the nutrient in question, e.g. serial measurements of levels of ascorbic acid in the plasma (32).

In the future it may become possible by chemical measurements made on a single occasion to conclude correctly that a given population is on the average either well-nourished, grossly deficient and diseased, or suffering from borderline or early de-

ficiency states. As yet, sufficient systematic evidence has not been collected through surveys to allow such conclusions. It would be highly useful if a complete battery of biochemical measurements, such as have been used on over 4,000 soldiers in different parts of the world (16), could be applied systematically to population groups suffering from florid deficiency states. Such surveys can contribute to the definition of borderline or early deficiency by delineating the differences between vigorous, healthy, and well-fed populations and the unfortunates who have frank nutritional disease.

USE OF THERAPEUTIC TRIALS AS A TOOL IN NUTRITION SURVEYS

One accepted method of confirming clinical diagnoses of nutritional disturbances or diseases is to observe the effect of therapy on the patient or on the group studied. For example, a good response to therapy in an individual patient with ariboflavinosis will occur when daily therapy with riboflavin is given for one to three weeks. However, the patient will relapse and physical signs will eventually recur when the riboflavin therapy is stopped, *provided that he eats the same diet, does the same work, and lives in the same environment* as he did when he was first seen by the physician. If riboflavin is given a second time the patient will again show a therapeutic response to riboflavin and with cure of the disease the clinical diagnosis of ariboflavinosis is completely confirmed (41). The response—relapse—response method of testing a nutrient is a thorough but difficult method of conducting a therapeutic diagnostic trial of vitamins, amino acids, or protein. Another method of conducting diagnostic therapeutic trials, and one which is more applicable to populations, is to divide the population under survey into two numerically equivalent groups, equally distributed with regard to age, sex, body build, activity, dietary intake, and clinical findings. Both groups must remain in the same environment and eat the same diet. One group is then given the vitamin or vitamins suspected of being deficient in the diet, either orally or parenterally. The second group is given a placebo which resembles the therapeutic agent as closely as possible in appearance and taste. Comparisons of the two groups are made at the end of the period of therapy. Any differences which are found can be attributed to the effects of therapy. When this kind of testing is done it is important that the physicians and other personnel who do the testing should not know which of the patients are getting placebos and which are getting therapeutically active substances.

A more rigid control is obtained by dividing the population under study into three equivalent groups, one group being given therapy, one group being given placebos, and one group being given no therapy whatsoever. The reason for doing this is that Wolf has recently shown (43) that placebos per se may have a profound effect on symptoms and signs in a population. In addition, Borsook (7) who gave placebos and vitamin supplements to aircraft workers in California found that "a larger number of the placebo than of the vitamin group reported benefits with respect to eye symptoms, weight gain, and miscellaneous conditions." If differences in the three groups occur, the responses or lack of responses in the untreated group and the placebo group will serve as a base line for measuring the response of the group given nutrient therapy. Curative effects of therapy over and above those observed

in the placebo and untreated control groups can be attributed to the nutrient under test, again provided that the basic pre-study dietary intakes, activity, and environment of the three groups have remained unchanged. At this point it must be emphasized that, while the majority of patients with malnutrition will respond to specific therapy with nutrients, there are some patients with long-standing nutritional disease whose lesions are irreversible. When this happens, repair of tissue will not take place, no matter how much therapy is given nor for how long. Irreversible lesions of this sort usually involve the central nervous system.

When vitamins are used for therapeutic diagnostic purposes it is customary to give them each day in amounts which are five times the recommended daily allowances for vitamins of the National Research Council, but this is not a hard and fast rule.

It is earnestly hoped that, when nutrition surveys are contemplated on populations, serious consideration will be given to repetitive surveys as means of testing the diagnostic value of vitamins or other nutrients employed as corrective agents.

PHYSICAL ENVIRONMENT IN NUTRITION SURVEYS

There is a seasonal variation in the incidence of some diseases such as upper respiratory infections and pellagra. In the field of nutrition this seasonal variation is further complicated by the usual harvest cycle, which tends to make populations better fed in the summer and autumn than in the winter and spring. For these reasons it is necessary to consider environmental effects in any survey, and, if possible, to examine the same groups repeatedly. Conclusions reached during a single survey made in one season may not be valid for the group at any other time of the year.

Many physical signs which may or may not be related to nutritional state are produced or aggravated by environmental trauma. Examples are pellagrous dermatitis, which is usually intensified by sunshine; the keratitis and conjunctivitis of snow-blindness, which are worst on gray, cloudy spring days; folliculosis, which is exacerbated by heavy winter clothing and lack of bathing, or by sweating and hard activity in the summer; changes in tendon reflexes, which may be associated with hard muscular work in environmental extremes; and the color of the skin, which is markedly altered by large changes in altitude.

Data on environmental influences on physical signs are remarkably scarce. Very little experimental work has been performed in this connection, and interpretation of the few field observations available is always difficult because of a multiplicity of complicating factors. Nutrition surveys can render a most valuable contribution to science by systematic study of physical signs as they vary in the same group under varying environmental conditions.

The consumption of foods and fluid is markedly affected by environmental conditions. Consumption of 5,000 calories or more per man per day is a common phenomenon among soldiers in an Arctic winter (16) and 4 liters or more of water per day are necessary to maintain water balance in the desert in summer (2). At the same time, calorie requirements in the desert and moist tropics are probably less than they are in colder environments (17). Similarly, evidence is accumulating to show

that some vitamin requirements for man may vary with the environmental temperature, an example being ascorbic acid as studied in troops exposed to Arctic cold (23).

As yet, most national and international bodies have taken environmental factors into account to only a limited extent if at all in setting up tables of recommended dietary allowances. Evidence such as that mentioned above suggests that eventually such considerations may be important. A significant contribution in this direction can be made by nutrition surveys.

POPULATION EFFICIENCY AND NUTRITION

There is a widespread belief among nutritionists that malnutrition in man is responsible for physical inefficiency and increased susceptibility to infectious diseases. For example, a report of a recent survey (1) concludes with the following statement: ". . . the poor nutritional status of the people of Newfoundland may well be in a large part responsible for their impaired health and efficiency." In this particular field of nutritional investigation clear-cut and convincing data are extremely scarce (22). For instance, few doubt that there is a close correlation between malnutrition and a high incidence of tuberculosis, and several well-known studies on this point have shown such a correlation, but clear-cut interpretations are complicated by many other socio-economic difficulties. Crowding, poor sanitation, malnutrition, and tuberculosis go hand in hand, and no one has been able to study tuberculosis purely in relation to malnutrition. As Getz remarks (11); "The concept that malnutrition predisposes to infectious disease and particularly tuberculosis, has been accepted largely on empirical grounds."

When gross signs of active and severe nutritional disease are found, loss of efficiency very often parallels organic involvement: for example, languor and weakness are commonly present in the nutritional anemias. On the other hand, when definite minor vitamin deficiencies and physical signs are found in human populations the problems of measurement of efficiency are so bound up with motivation and environmental problems as to be well nigh uninterpretable at this juncture on the basis of nutritional deficiency alone (22).

Caloric deficiency, whether acute or chronic, shows some pretty correlations between efficiency and the degree of deficiency. Kraut and Muller (25) demonstrated an almost quantitative relationship in Ruhr miners between coal production and caloric intake. The fewer the calories, the less coal was mined, despite the patriotic incentive to produce maximally during a war. It has also been observed that slight caloric deficiencies which cannot be recognized clinically or by present biochemical techniques in an individual can, when widespread in a group, diminish the efficiency of the group (16). Similar good correlations can be noted between dehydration and loss of efficiency (2, 30), between oxygen lack and dyspnea (12), and to a lesser degree between iron-deficiency anemia and weakness.

When protein or vitamin subnutrition exists (by North American standards) some data are apparently at variance with present concepts. For instance, among the Gurkhas (inhabitants of the independent Himalayan State of Nepal) excellent physical fitness and tactical military efficiency are compatable with very low levels, by North American standards, of intake of several important nutrients and, in addition,

very low levels of these nutrients in the blood and urine (16). Moreover, it is common clinical knowledge that some waterlogged patients with cardiac beri-beri show a surprising ability to work without dyspnea, in contrast to patients in heart failure as a result of other diseases, such as rheumatic fever. In addition, among laborers doing heavy work, calorically well-nourished pellagrins and scorbutics have been observed to be able to do a surprising amount of work provided their calorie intake is adequate, when compared with individuals who are well nourished but untrained and sedentary.

Nevertheless, experimentally induced vitamin deficiencies in man seem to show some correlations between the development of physical signs and loss of efficiency (15, 24). One is tempted to explain the apparent contradictions by postulating that experimentally produced deficiency syndromes in man are not the exact counterparts of naturally occurring borderline vitamin deficiencies, as presently diagnosed in the field or in the clinic. For example, Crandon (9), living on a vitamin-C-free diet, developed perifollicular hemorrhages in the skin of the legs but did not develop spongy bleeding gums, anemia, or a positive tourniquet test, three common findings in scurvy. Another explanation is that many observers have accepted certain minor aberrations in surface tissues as being pathognomonic or patent signs of nutritional deficiency disease. That this is an unsound concept has been ably demonstrated by Dann and Darby (10) and has been discussed above. Therefore, it is believed that further investigations are now required concerning the single and concerted effects of different types of malnutrition and environmental stresses on the physical and mental efficiency, and on the health, of population groups. One way of obtaining these data is by conducting well-rounded nutritional surveys.

Measurements of efficiency are notoriously difficult to interpret, because "good" scores depend on good motivation; because reproducibility of data depends on the elimination of the learning phenomenon; because efficiency or "good" scores in one type of test often do not correlate with efficiency or "good" scores measured in another way; and because efficiency and "good" physical fitness obtained in tests do not imply efficiency or fitness for true life situations. The most widely used physical fitness test, the Harvard step test (16), which is a useful test for assessing active young adults, cannot be used for testing children, the aged, or the infirm. We do not recommend the routine use of any "fitness test" in general surveys.

COMPOSITION, SCOPE, AND FUNCTIONS OF SURVEY TEAMS

The collection of data during nutrition surveys depends a great deal on the available personnel and equipment. For example:

A. One trained layman can conduct a height-weight survey, using standard scales and measurements.
B. One physician with clerical help can do a rapid survey on general health.
C. One dietitian or home economist can conduct a rough quantitative survey of food intake.
D. One biochemist can make measurements of blood and urine chemistry, given space and equipment.

Combinations of individuals noted in A, B, C, and D above can do adequate

complete surveys in temperate zones where public health is good. In areas of environmental hazard and prevalent disease, specialists are required in addition to other team personnel (e.g., an X-ray technician in areas where tuberculosis is prevalent; a parasitologist in the tropics). A team that worked successfully for the Army included a physician, a biostatistician, a nutrition officer, a food specialist, and a physician-biochemist. An ideal survey team would include a wide variety of specialists, such as sociologists, agronomists, food technologists, and anthropologists, among others, and would make repetitive surveys as outlined previously.

Finally, in our opinion a nutrition survey should take into account the total environment of the group under study and is of little public health value unless it can include practical suggestions for improvement of health (if necessary), made by the competent experts, whether anthropologists, agronomists, or physicians.

SUMMARY

The view is supported that in medical nutrition surveys there is no such thing as a single pathognomonic physical sign of specific nutritional deficiency; that interpretation of clinical findings in a given individual requires careful differential diagnosis, including history, physical examination, and laboratory findings; and that in many instances, a therapeutic diagnosis is necessary to settle clinical judgments, with the reservation that irreversible tissue change as a result of prolonged disease sometimes does not respond to any therapy.

The composition, scope, and functions of survey teams of various types are discussed, with emphasis on the idea that a medical nutrition survey is of little value unless it takes into account the total environment of the group under study and unless it can include practical suggestions for improvement of health (if necessary) by competent experts, whether anthropologists, agronomists, or physicians.

A strong plea is made for standardization of methods among various teams, and suggested minimum observations are presented, along with a proposed check list for physical examination.

APPENDIX A

CHECK SHEET FOR NUTRITIONAL SURVEYS

Wet . . . °C. . . . °F.
Place . . . . . Date . . . . . Outdoor Temp. . . . Dry . . . °C. . . . °F.
Altitude . . . . . Meters . . . . . .
Subject's Name . . . . . Age . . . . . Sex . . . . . .
Race: White . . Black . . Red . . Yellow . . Brown . . Mixed . . Other . .
National Group . . . . . .
Religious Group . . . . . .
History: . . . . None . . . . Obtained by Physician, Interpreter.
Spontaneous Complaints . . . . None. If other detail:
. . . . . .
. . . . . .
. . . . . .
. . . . . .

Elicited Complaints....None. If other detail:

.....

.....

.....

.....

Conditioning Factors....None. If other detail:

.....

.....

.....

.....

Dietary History: ....None. Obtained by Physician, Dietitian, Home Economist, Interpreter,.....

Recorded on Dietary Form.....

If other, detail: .....

.....

.....

Physical Examination:

Height: Cms. with footgear.....Cms. without footgear.....

Height of heels (Approx).....cms.

Weight: Kgs. with clothes.....Kgs. without clothes.....Kgs.

Weight of clothes (Approx).....Kgs.

General Condition:

....Up and about.....Bedridden.....Other.....

....Alert.....Apathetic.....Other.....

....Well Developed.....Poorly.....Other.....

....Obese.....Well Nourished.....Thin.....

.....Wasted.....Other.....

....Other

EYES:

.....No abnormalities

.....Disturbances of vision: If present, detail.....

.....Photophobia

.....Dryness

.....Disturbance of movement: If present, detail.....

.....Bitot's spots

.....Gross changes in opacity of sclera, 1.....Slight:

2.....Moderate: 3.....Severe.

.....Gross changes in opacity of cornea

.....Sclerocorneal vascularity. 1.....Slight:

2.....Moderate: 3.....Severe.

.....Old corneal injury

.....Follicular conjunctivitis

.....Gross conjunctivitis: 1.....Slight: 2.....Moderate; 3.....Severe:
.....Injection of vessels at equator of bulbar conjunctiva
.....Pterygia
.....Pingueculae
.....Not examined
.....Other: If present, detail

LIPS AND MOUTH:

.....No abnormalities
.....Aphonia: If present, detail
.....Angular fissure in absence of false teeth
.....Cheilosis
.....Color of tongue:.....Normal: If not detail,.....
.....Edema of tongue: 1.....Slight; 2.....Moderate; 3.....Severe.
.....Papillae and mucous membrane of tongue...Normal: If other detail.
.....Stomatitis: 1.....Slight; 2.....Moderate; 3.....Severe.
.....Chronic gingivitis: 1.....Slight; 2.....Moderate; 3.....Severe
.....Active acute inflammation of dental margin. 1.....Slight; 2.....Moderate; 3.....Severe.
.....Retraction or recession of gums
.....Swelling of interdental papillae
.....Bleeding of gums, either spontaneous or in slight trauma.
.....Oral hygiene: 1.....Good; 2.....Fair; 3.....Poor.
.....Abnormal pigmentation of buccal mucosa.
If present, location and nature:.....
.....Not examined
.....Other: If present, detail:.....

SKIN:

.....No abnormalities
.....Anemia of palms and mucous membranes.
.....Xerosis
.....Follicular hyperkeratosis; 1....Slight; 2....Moderate; 3....Severe.
If present, area.....
.....Acneiform eruption; 1.....Slight; 2.....Moderate; 3.....Severe.
If present, area.....
.....Seborrheic dermatitis: If present, area.....
.....Psoriasis: If present, area.....
.....Acne rosacea
.....Eczema: If present, area.....
.....Telangiectasis: If present, area.....
.....Acrodynia
.....Jaundice

.....Dermatitis (pellagrous or pellagrous-like complex)

Erythema .....
Pigmentation .....
Depigmentation .....
Blisters .....
Cracks .....
Thickening .....
Infected .....
Area (describe).....
1.....Acute; 2.....Chronic; 3.....Slight;
4.....Moderate; 5.....Severe.

.....Thickening and pigmentation of skin at elbows or knees. If present, details.....

.....Miliaria: 1.....Slight; 2.....Moderate; 3.....Severe.
If present, area.....

.....Traumatic dermatitis: 1....Slight; 2....Moderate; 3....Severe.
If present, area.....

.....Dermatitis of fungus infection: 1.....Slight; 2.....Moderate;
3.....Severe. If present, area.....

.....Periofolliculosis without hemorrhage.

.....Petechial hemorrhages. If present, area.....

.....Purpura: If present, area.....

.....Not examined.

.....Other: If present, detail. (Especially "cracked" skin, "blackheads", "whiteheads", suborbital pigmentation)

TRUNK:

Heart

.....Normal

.....If abnormal, detail.....

.....Pulse rate
.....Blood pressure
} Position when measured.

Chest

.....Normal

.....If abnormal, detail

Abdomen

.....Normal

.....Liver enlarged: Detail.

.....Spleen enlarged: Detail

.....Other abnormalities: Detail

ENDOCRINE AND LYMPHATIC:

.....Normal

.....If abnormal: Detail

EXTREMITIES:

.....No abnormalities
.....Brittleness of nails
.....Grooving or pitting of nails
.....Spooning of nails
.....Pigmentation. If present, area.....
.....Palmar erythema
.....Epidermophytosis of hands or feet. 1.....Mild; 2.....Moderate; 3.....Severe. If present, location.....
.....Not examined
.....Other; If present, detail

NEUROMUSCULAR AND LOCOMOTOR:

.....No abnormalities
.....Muscular weakness
.....Knee jerks absent: 1.....Right; 2.....left; 3.....Both.
.....Ankle jerks absent: 1.....Right; 2.....Left; 3.....Both.
.....Tenderness of belly of gastrocnemius
.....Nerve tenderness: If present, location.....
.....Hyperesthesia: If present, location.....
.....Vibratory sense lost on malleoli: 1.....Right; 2.....Left; 3.....Both.
.....Anesthesia: If present, location.....type.....
.....Symmetrical muscular atrophy in extremities.
.....Pretibial pitting edema
.....Pitting edema of feet
.....Pitting edema over sacrum
.....Spasticity: If present, detail
.....Romberg's sign
.....Squatting test positive
.....Signs of rickets. If present, detail
.....Signs of osteomalacia. If present, detail
.....Other bone disturbances. If present, detail
.....Not examined
.....Other: If present detail

FOR CHILDREN AND ADOLESCENTS.

Age.....Years.....months.
Height (without shoes).....cm. or.....inches
Weight (minimum clothes).....kg. or.....lbs.
Hip width.....cm. or.....inches
Chest circumference.....cm. or.....inches
(middle of inspiration-expiration)

Skin and fat thickness

Back.....cm. or.....inches or.....grade

Ilium.....cm. or.....inches or.....grade

DETAILED DESCRIPTIONS OF ABNORMAL FINDINGS

Diagnoses

Nutritional Status Satisfactory.....

Nutritional Status Abnormal.....Specify.....

No other disease processes.....

Other disease processes..... ....

If present, diagnosis.

Section IV

APPENDIX B

A short bibliography of clinical publications on some important diseases and syndromes which occur spontaneously in man and which are or may be related to malnutrition.

I. *WATER*

A. *Dehydration*

1. Marriott, W. McK.: Anhydremia. Physiol. Rev., *3:* 275–294, 1923.
2. Gamble, J. L.: Dehydration. New England J. Med., *201:* 909–917, 1929.
3. Nadal, J. W., Pedersen, S., and Maddock, W. G.: Comparison Between Dehydration from Salt Loss and from Water Deprivation. J. Clin. Invest., *20:* 691–703, 1941.
4. Marriott, H. L.: Water and Salt Depletion (Croonian Lectures). Brit. Med. J., *1:* 245, 285, 328, 1947.

B. *Dehydration Syndrome*

1. Pitts, G. C., Johnson, R. E., and Consolazio, F. C.: Work in the Heat as Affected by Intake of Water, Salt, and Glucose. Am. J. Physiol., *142:* 253–259, 1944.
2. Adolph, E. F.: The Physiology of Man in the Desert. New York. Interscience Publishing Co., 1947.

C. *Heat Exhaustion*

1. Ladell, W. S. S., Waterlow, J. C., and Hudson, M. F.: Desert Climate; Physiological and Clinical Observations. Lancet, *2:* 491, 527, 1944.

II. *CALORIES*

A. *Obesity*

1. Epstein, A. A.: Clinical and Biological Considerations of Obesity and Certain Allied Conditions. Bull. New York Acad. Med., *10:* 389–414, 1934.
2. Newburgh, L. H. and Johnston, M. W.: Obesity. Med. Clin. North America, *27:* 327–347, 1943.

B. *Starvation*

1. Benedict, F. G.: A Study of Prolonged Fasting. Carnegie Institution of Washington, 1915, p. 416.
2. Fleming, G. B.: Investigation into Metabolism in Infantile Atrophy, with Special Reference to the Respiratory Exchange. Quart. J. Med., *14:* 171–186, 1921.
3. Benedict, F. G.: Metabolism During Starvation and Undernutrition. New York Med. J., *115:* 249–256, 1922.
4. Fleming, G. B. and Hutchinson, H. S.: Metabolism in Undernourished Infants. Quart. J. Med., *17:* 339–357, 1924.

5. Wilkinson, P. B.: Deficiency Diseases in Hong Kong. Lancet, *2:* 655–658, 1944.
6. Lipscomb, F. M.: Medical Aspects of Belsen Concentration Camp. Lancet, *2:* 313–315, 1945.
7. Burger, G. C. E., Sandstead, H. R., and Drummond, J.: Starvation in Western Holland. Lancet, *2:* 282–283, 1945.
8. Spillane, J. D.: Partial Starvation in Prisoners of War. Lancet, *2:* 317–318, 1945.
9. Leyton, G. B.: Effects of Slow Starvation. Lancet, *2:* 73–79, 1946.
10. Burgess, R. C.: Deficiency Diseases in Prisoners of War at Changi, Singapore, February 1942 to August 1945. Lancet, *2:* 411–418, 1946.
11. Mitchell, J. B. and Black, J. A.: Malnutrition in Released Prisoners of War and Internees at Singapore. Lancet, *2:* 855–862, 1946.

C. *Ketonuria with Involuntary Dehydration*

1. Kark, R. M., Johnson, R. E., and Lewis, J. S.: Defects of Pemmican as an Emergency Ration for Infantry Troops. War Medicine, *7:* 345–352, 1945.

III. *PROTEINS*

A. *Nutritional Edema*

1. Maver, M. B.: Nutritional Edema and "War Dropsy". J. A. M. A., *74:* 934–941, 1920.
2. Weech, A. A. and Ling, S. M.: Nutritional Edema; Observations on Relation of Serum Proteins to Occurrence of Edema and to Effect of Certain Inorganic Salts. J. Clin. Invest., *10:* 869–888, 1931.
3. Weech, A. A.: Fluid Distribution and Edema. Bull. New York Acad. Med., *10:* 269–288, 1934.
4. Youmans, J. B.: Nutritional Edema. *In* International Clinics, IV. Philadelphia. J. B. Lippincott Co., 1936.
5. Kurnick, N. B.: War Edema in the Civilian Population of Saipan. Ann. Int. Med., *28:* 782–789, 1948.

B. *Growth and Development*

1. Gardiner-Hill, H.: Abnormalities of Growth and Development; The Clinical and Pathological Aspects (Oliver Sharpey Lecture). Brit. Med. J., *1:* 1302–1308, 1937.

IV. *FATS, FATTY ACIDS*

A. *Fat Deficiency*

1. Hansen, A. E. and Burr, G. O.: Studies in Iodine Absorption of Serum in Rats Fed on Fat-Free Diets. Iodine Numbers of Serum Lipids in Rats Fed on Fat-Free Diets. Proc. Soc. Exp. Biol. and Med., *30:* 1200–1203, 1933.

B. *Infantile Eczema*

1. Hansen, A. E.: Serum Lipids in Eczema and Other Pathologic Conditions. Am. J. Dis. Child., *53:* 933–946, 1937.

C. *Fibrocystic Disease of Pancreas*

1. Andersen, D. H.: Cystic Fibrosis of the Pancreas and its Relation to

Celiac Disease; Clinical and Pathological Study. Am. J. Dis. Child., *56:* 344–399, 1938.

V. *MINERALS*

A. *Acid-Base Imbalance*

1. Darrow, D. C.: The Pharmacopea and the Physician Treatment of Dehydration, Acidosis, and Alkalosis. J. A. M. A., *114:* 655–660, 1940.
2. Singer, R. B. and Hastings, A. B.: An Improved Clinical Method for the Estimation of Disturbances of the Acid-Base Balance of Human Blood. Medicine, *27:* 223–242, 1948.

B. *Iron Deficiency Anemia* (*Infancy, Adolescence, Pregnancy, Menopause, Plummer-Vinson Syndrome*)

1. Suzman, M. M.: Syndrome of Anemia, Glossitis and Dysphagia; Report of Eight Cases with Special Reference to Observations at Autopsy in One Instance. Arch. Int. Med., *51:* 1–21, 1933.
2. Heath, C. W. and Patek, A. J., Jr.: The Anemia of Iron Deficiency. Medicine, *16:* 267–350, 1937.
3. Fullerton, H. W.: Iron Deficiency of Late Infancy. Arch. Dis. Childhood, *12:* 91–110, 1937.
4. Josephs, H. W.: Iron Metabolism in Infancy; Factors Influencing Iron Retention on Ordinary Diets. Bull. Johns Hopkins Hosp., *65:* 145–166, 1939.

C. *Tetany* (*Infantile and Adult*)

1. Pincus, J. B. and Gittleman, I. F.: Infantile Tetany; Metabolic Study. Am. J. Dis. Child., *51:* 816–822, 1936.
2. Bakwin, H.: Pathogenesis of Tetany of the Newborn. Am. J. Dis. Child., *54:* 1211–1226, 1937.

D. *Osteomalacia*

1. Maxwell, J. P.: Further Studies in Adult Rickets (Osteomalacia) and Foetal Rickets. Proc. Roy. Soc. Med., *28:* 265–300, 1935.
2. Maxwell, J. P.: The Modern Conception of Osteomalacia and Its Importance to China. Chinese Med. J., *49:* 47–52, 1945.
3. Liu, S. H. et al.: Calcium and Phosphorus Metabolism in Osteomalacia: Effect of Varying Levels and Ratios of Calcium to Phosphorus Intake on Their Serum Levels, Paths of Excretion, and Balances, in the Presence of Continuous Vitamin D Therapy. J. Clin. Invest., *16:* 603–611, 1937.
4. Taylor, G. F. and Day, C. D. M.: Osteomalacia and Dental Caries. Brit. Med. J., *2:* 221–222, 1940.
5. Maxwell, J. P. and Pi, H. T.: Cataract in Adult Rickets (Osteomalacia). Proc. Roy. Soc. Med., *33:* 777–782, 1940.
6. Kenny, M.: A Case of Osteomalacia. Proc. Roy. Soc. Med., *34:* 801–804, 1941.
7. Albright, F., Burnett, C. H., Parson, W., Reifenstein, E. C., and Roos, A.: Osteomalacia and Late Rickets. The Various Etiologies Met in the U. S., with Emphasis on that Resulting from a Specific Form of

Renal Acidosis, the Therapeutic Indications for Each Etiological Sub-Group, and the Relationship between Osteomalacia and Milkman's Syndrome. Medicine, *25:* 399–477, 1946.

E. *Osteoporosis*

1. Mendenhall, A. M. and Drake, J. C.: Calcium Deficiency in Pregnancy and Lactation; Clinical Investigation. Am. J. Obst. & Gynec., *27:* 800–807, 1934.
2. Camp, J. D. and McCullough, J. A. L.: Pseudofractures in Diseases Affecting the Skeletal System. Radiology, *36:* 651–663, 1941.

F. *Milkman's Syndrome*

1. Milkman, L. A.: Pseudofractures (Hunger Osteopathy, Later Rickets, Osteomalacia), Report of Case. Am. J. Roentgenol., *24:* 29–37, 1930.
2. Milkman, L. A.: Multiple Spontaneous Ideopathic Symmetrical Fractures. Am. J. Roentgenol., *32:* 622–634, 1934.
3. Edeiken, L. and Schneeberg, N. G.: Multiple Spontaneous Idiopathic Symmetrical Fractures (Milkman's Syndrome). J. A. M. A., *122:* 865–870, 1943.

G. *Heat Cramps (Stokers' Cramp, Miners' Cramp)*

1. Talbott, J. H.: Heat Cramps. Medicine, *14:* 323–376, 1935.
2. Dill, D. B.: Life, Heat and Altitude; Physiological Effects of Hot Climates and Great Heights. Harvard University Press, 1938.
3. Talbott, J. H.: Handbook of Nutrition; Water and Salt Requirements in Health and Disease. J. A. M. A., *119:* 1418–1425, 1942.

H. *Goiter*

1. Marine, David: The Pathogenesis and Prevention of Simple or Endemic Goiter. Proc. Inst. Med., *5:* 31–46, 1924.
2. Marine, David: The Pathogenesis and Prevention of Simple or Endemic Goiter, J. A. M. A., *104:* 2334–2341, 1935.
3. Means, J. H.: The Thyroid and Its Diseases. Philadelphia. J. B. Lippincott Co., 1937.

VI. *FAT SOLUBLE VITAMINS*

A. *Vitamin A Deficiency (General)*

1. Widmark, E.: Vitamin A Deficiency in Denmark and Its Results. Lancet, *1:* 1206–1209, 1924.
2. Sweet, L. K. and K'Ang, H. J.: Clinical and Anatomic Study of Avitaminosis A Among the Chinese. Am. J. Dis. Child., *50:* 699–734, 1935.
3. Loewenthal, L. J. A.: The Manifestations of Vitamin A Deficiency in Man. Ann. Trop. Med., *29:* 407–413, 1935.
4. Nicholls, L. and Nimalasuriya, A.: Bitot's Spots in Ceylon. Lancet, *1:* 1432–1434, 1939.

B. *Night Blindness*

1. Bloch, C. E.: Blindness and Other Diseases in Children Arising from Deficient Nutrition (Lack of Fat-Soluble Vitamin A Factor). J. Dairy Sci., *7:* 1–10, 1924; Am. J. Dis. Child., *27:* 139–148, 1924.

2. Wittkower, E. and Rodger, T. F.: Night Blindness, A Psychophysiological Study. Brit. Med. J., *2:* 571, 607, 1941.

C. *Xerophthalmia*

1. Bloch, C. E.: Clinical Investigation of Xerophthalmia and Dystrophy in Infants and Young Children (Xerophthalmia et Dystrophia Alipogentica). J. Hygiene, *19:* 283–304, 1921.
2. Blegvad, O.: Xerophthalmia, Keratomalacia and Xerosis Conjunctivae; with Bibliography. Am. J. Ophth., *7:* 89–117, 1924.
3. Blackfan, K. D. and Wolbach, S. B.: Vitamin A Deficiency in Infants; Clinical and Pathological Study. J. Pediat., *3:* 679–706, 1933.

D. *Phrynoderma*

1. Nicholls, L.: Phrynoderma: A Condition Due to Vitamin Deficiency. Indian Med. Gazette, *68:* 681–686, 1933; *69:* 241, 1934.
2. Nicholls, L.: Inspectional Value of Phrynoderma and Sore Mouth. Indian Med. Gazette, *70:* 14–15, 1935.
3. Frazier, C. N. and Hu, C. K.: Nature and Distribution According to Age of Cutaneous Manifestations of Vitamin A Deficiency: A Study of 207 Cases. Arch. Dermat. & Syph., *33:* 825–852, 1936.
4. Rao, M. V. R.: Histopathology of the Skin in Keratomalacia. Indian J. Med. Res., *25:* 39–44, 1937.
5. Rao, M. V. R.: Phrynoderma: A Clinical and Histopathological Study. Indian Med. Gazette, *73:* 461–462, 1938.
6. Frazier, C. N., Hu, C. K., and Chu, F. T.: Variations in the Cutaneous Manifestations of Vitamin A Deficiency from Infancy to Puberty. Arch. Dermat. & Syph., *48:* 1–14, 1943.

E. *Rickets*

1. Chick, H. et al.: Studies of Rickets in Vienna, 1919–22. Med. Res. Council Special Report Series *77*. London, 1923, p. 230.
2. Weech, A. A. and Smith, M. S.: Anatomic Basis for Interpreting Roentgenograms in Rickets. Am. J. Dis. Child., *26:* 117–131, 1923.
3. Wimberger, H.: Klinisch-Radiologische Diagnostik von Rachitis, Skorbut und Lues Congenita im Kindesalter. Ergebn. d. inn. Med. u. Kinderh., *28:* 264–270, 1925.
4. Parsons, L. G.: The Bone Changes Occurring in Renal and Celiac Infantilism and Their Relationship to Rickets; Renal Rickets. Arch. Dis. Childhood., *2:* 1–25, 1927.
5. Park, E. A.: Blackader Lecture on Some Aspects of Rickets. Canad. Med. Assoc. J., *26:* 3–15, 1932.
6. Bromer, R. S.: Rickets. Am. J. Roentgenol., *30:* 582–589, 1933.
7. Cooley, T. B. and Reynolds, L.: The Interpretation of X-Ray Films in the Diagnosis of Rickets. J. Pediat., *10:* 743–747, 1937.
8. Park, E. A. and Eliot, M. M.: Rickets. *In* Brennemann, Joseph, Ed.: Practice of Pediatrics III, Chap. 29. Hagerstown, Md. W. F. Prior Co., 1937.

9. Albright, F., Butler, A. M., and Bloomberg, E.: Rickets Resistant to Vitamin D Therapy. Am. J. Dis. Child., *54:* 529–547, 1937.
10. Park, E. A.: Observations on the Pathology of Rickets with Particular Reference to the Changes at the Cartilage-Shaft Junctions of the Growing Bones (Harvey Lecture). Bull. New York Acad. Med., *15:* 495–543, 1939.
11. McCune, D. J., Mason, H. H., and Clarke, H. T.: Late Rickets with Glycosuria and Organic Acid Acidosis (Fanconi Type). Am. J. Dis. Child., *58:* 673, 1939.

F. *Hypoprothrombinemia*

1. Brinkhous, K. M., Smith, H. P., and Warner, E. D.: Plasma Prothrombin Level in Normal Infancy and in Hemorrhagic Disease of the Newborn. Am. J. Med. Sci., *193:* 475–480, 1937.
2. Dam, H. and Glavind, J.: Vitamin K in Human Pathology. Lancet, *1:* 720–721, 1938; Ugesk, f. Laeger, *100:* 248–250, 1938.
3. Butt, H. R., Snell, A. M., and Osterberg, A. E.: The Preoperative and Postoperative Administration of Vitamin K to Patients Having Jaundice. J. A. M. A., *113:* 383–389, 1939.
4. Kato, K. and Poncher, H. G.: Prothrombin in the Blood of Mature and Immature Infants as Determined by Micro-prothrombin Test. J. A. M. A., *114:* 749–753, 1940.
5. Poncher, H. G. and Kato, K.: Treatment of Hypoprothrombinemia Heamorrhagica Neonatorum (Hemorrhagic Disease of the Newborn) with Vitamin K. J. A. M. A., *115:* 14–17, 1940.
6. Brinkhous, K. M.: Plasma Prothrombin; Vitamin K. Medicine, *19:* 329–416, 1940.
7. Kark, R. and Souter, A. W.: Hypoprothrombinaemia and Avitaminosis-K in Man. Brit. Med. J., *2:* 190–194, 1941.
8. Butt, H. R. and Snell, A. M.: Vitamin K. Philadelphia and London. W. B. Saunders Co., 1941.

VII. *WATER-SOLUBLE VITAMINS*

A. *Beriberi (Infantile and Adult)*

1. Fraser, H. and Stanton, A. T.: An Inquiry Concerning the Etiology of Beri-beri. Lancet, *1:* 451–455, 1909.
2. Shattuck, G. C.: Relation of Beri-beri to Polyneuritis from Other Causes. Am. J. Trop. Med., *8:* 539–543, 1928.
3. Aalsmeer, W. C. and Wenckebach, K. F.: Herz und Kreislauf bei der Beriberi-Krankheit. Wien Arch. f. inn. Med., *16:* 193, 1929.
4. Vedder, E. B.: Beriberi. *In* Tice, Frederick, Ed.: Practice of Medicine IX. Hagerstown, Md. W. F. Prior Co., 1929.
5. Keefer, C. S.: Beriberi Heart. Arch. Int. Med., *45:* 1–22, 1930.
6. Shimazono, J.: B-Avitaminosis und Beriberi. Ergebn. d. inn. Med. u. Kinderh., *39:* 1–68, 1931.
7. Weiss, S. and Wilkins, R. W.: The Nature of the Cardiovascular Dis-

turbances in Vitamin Deficiency States. Tr. Assoc. Am. Physicians, *51:* 341–373, 1936.

8. Platt, B. S. and Lu, G. D.: Chemical and Clinical Findings in Beriberi, with Special Reference to Vitamin B Deficiency. Quart. J. Med., *5:* 355–373, 1936.
9. Weiss, S. and Wilkins, R. W.: The Nature of the Cardiovascular Disturbances in Nutritional Deficiency States (Beriberi). Ann. Int. Med., *11:* 104–148, 1937.
10. Weiss, S. and Wilkins, R. W.: Disturbance of the Cardiovascular System in Nutritional Deficiency. J. A. M. A., *109:* 786–793, 1937.
11. Bray, G. W.: Vitamin B. Deficiency in Infants; Its Possibility, Prevalence and Prophylaxis. Tr. Roy. Soc. Trop. Med. & Hyg., *22:* 9–42, 1928.
12. Hibbs, R. E.: Beriberi in a Japanese Prison Camp. Ann. Int. Med., *25:* 270–282, 1946.

B. *Ariboflavinosis*

1. Aykroyd, W. R. and Krishnan, B. G.: Stomatitis Due to Vitamin B_2 Deficiency. Indian J. Med. Res., *24:* 411–417, 1936.
2. Sebrell, W. H. and Butler, R. E.: Riboflavin Deficiency in Man. U. S. Pub. Health Rep., *53:* 2282–2284, 1938.
3. Sydenstricker, V. P., Geeslin, L. E., Templeton, C. M., and Weaver, J. W.: Riboflavin Deficiency in Human Subjects. J. A. M. A., *113:* 1697–1700, 1939.
4. Spies, T. D., Bean, W. B., Vilter, R. W., and Huff, N. E.: Endemic Riboflavin Deficiency in Infants and Children. Am. J. Med. Sci., *200:* 697–701, 1940.
5. Sydenstricker, V. P., Sebrell, W. H., Cleckley, H. M., and Kruse, H. D.: The Ocular Manifestations of Ariboflavinosis; Progress Note. J. A. M. A., *114:* 2437–2445, 1940.
6. Aykroyd, W. R. and Verma, O. P.: Superficial Keratitis Due to Riboflavin Deficiency. Indian Med. Gazette, *77:* 1–4, 1942.
7. Stannus, H. S.: Some Problems in Riboflavin and Allied Deficiencies (Lumleian Lectures). Brit. Med. J., *2:* 103, 140, 1944.

C. *Scurvy, Infantile (Barlow's Disease) and Adult*

1. Hess, A. F.: Subacute and Latent Infantile Scurvy. J. A. M. A., *68:* 235–239, 1917.
2. Hess, A. F.: Infantile Scurvy. *In* Abt, I. A., Ed.: System of Pediatrics II, Chap. 30. Philadelphia. W. B. Saunders Co., 1923.
3. Pelkan, K. F.: The Roentgenogram in Early Scurvy. Am. J. Dis. Child., *30:* 174–188, 1925.
4. Schwartz, A. B.: Epiphyseal Changes in the Diagnosis of Scurvy. Am. J. Dis. Child., *34:* 765–772, 1927.
5. Bromer, R. S.: The Roentgen-Ray Diagnosis of Infantile Scurvy. Am. J. Roentgenol., *19:* 112–125, 1928.
6. Mettier, S. R., Minot, G. R., and Townsend, W. C.: Scurvy in Adults;

Especially, the Effect of Food Rich in Vitamin C on Blood Formation. J. A. M. A., *95:* 1089–1093, 1930.

7. Kato, K.: Critique of the Roentgen Signs of Infantile Scurvy, with Report of Thirteen Cases. Radiology, *18:* 1096–1110, 1932.
8. Barlow, T.: On Cases Described as "Acute Rickets" Which Are Probably a Combination of Scurvy and Rickets, the Scurvy Being an Essential and the Rickets a Variable Element. Arch. Dis. Childhood, *10:* 223–252, 1935.
9. Park, E. A., Guild, H. G., Jackson, D., and Bond, M.: Recognition of Scurvy with Especial Reference to Early X-Ray Changes. Arch. Dis. Childhood, *10:* 265–294, 1935.
10. Jenovese, J. F., Osterberg, A. E., and Rynearson, E. H.: Role of Vitamin C in Addison's Disease. Proc. Soc. Exp. Biol. & Med., *44:* 335–339, 1940.
11. Fox, F. W., Dangerfield, L. F., Gottlich, S. F., and Jokl, E.: Vitamin C Requirements of Native Mine Laborers; Experimental Study. Brit. Med. J., *2:* 143–147, 1940.
12. Scarborough, H.: Deficiency of Vitamin C and Vitamin P in Man. Lancet, *2:* 644–647, 1940.
13. Bromer, R. S.: Roentgen-Ray Diagnosis of Infantile Scurvy. Am. J. Roentgenol., *19:* 112–125, 1928; *49:* 575–579, 1943.
14. Blitz, D.: Infantile Scurvy; Case Report with Follow-Up Roentgenogram of Pre-Existent Healed Scurvy. J. Pediat., *23:* 87–89, 1943.
15. McMillan, R. B. and Inglis, J. C.: Scurvy: A Survey of Fifty-three Cases. Brit. Med. J., *2:* 233–236, 1944.

VIII. *SPECIFIC AND COMBINED NUTRITIONAL DEFICIENCIES*

A. *Pellagra (Infantile and Adult)*

1. Stannus, H. S.: Pellagra in Nyasaland Tr. Roy. Soc. Trop. Med. & Hyg., *5:* 112–119, 1911–12; *7:* 32–56, 1913–14.
2. Bloch, C. E.: Effects of Deficiency in Vitamins in Infancy; Caries of Teeth and Vitamins. Am. J. Dis. Child., *42:* 263–278, 1931.
3. Spies, T. D., Chinn, A. B., and McLester, J. B.: Severe Endemic Pellagra; Clinical Study of Fifty Cases, with Special Emphasis on Therapy. J. A. M. A., *108:* 853–857, 1937.
4. Sydenstricker, V. P. and Armstrong, E. S.: Review of 440 Cases of Pellagra. Arch. Int. Med., *59:* 883–891, 1937.
5. Trowell, H. C.: Pellagra in African Children. Arch. Dis. Childhood, *12:* 193–212, 1937.
6. Spies, T. D., Bean, W. B., and Stone, R. E.: The Treatment of Subclinical and Classic Pellagra. J. A. M. A., *111:* 584–592, 1938.
7. Cleckley, H. M., Sydenstricker, V. P., and Geeslin, L. E.: Nicotinic Acid in the Treatment of Atypical Psychotic States Associated with Malnutrition. J. A. M. A., *112:* 2107–2110, 1939.
8. Spies, T. D., Walker, A. A., and Woods, A. W.: Pellagra in Infancy and Childhood. J. A. M. A., *113:* 1481–1483, 1939.

9. Trowell, H. C.: Infantile Pellagra. Tr. Roy. Soc. Trop. Med. & Hyg., *33:* 389–404, 1940.
10. Field, H., Jr., Parnall, C., Jr., and Robinson, W. D.: Pellagra in an Average Population of Northern States. New England J. Med., *223:* 307–315, 1940.
11. Bean, W. B., Spies, T. D., and Blankenhorn, M. A.: Secondary Pellagra. Medicine, *23:* 1–77, 1944.
12. Bean, W. B., Spies, T. D., and Vilter, R. W.: Asymmetric Cutaneous Lesions in Pellagra. Arch. Derm. & Syph., *49:* 335–345, 1944.

B. *Addisonian Pernicious Anemia*

1. Minot, G. R. and Murphy, W. P.: Treatment of Pernicious Anemia by a Special Diet. J. A. M. A., *87:* 470–476, 1926.
2. Minot, G. R. and Murphy, W. P.: Treatment of Pernicious Anemia by a Special Diet. Blood, *3:* 8–21, 1948.
3. Haden, R. L.: Pernicious Anemia from Addison to Folic Acid. Blood, *3:* 22–31, 1948.
4. Bethell, F. H. and Sturgis, C. C.: The Relation of Therapy in Pernicious Anemia to Changes in the Nervous System; Early and Late Results in a Series of Cases Observed for Periods of Not Less than Ten Years, and Early Results of Treatment with Folic Acid. Blood, *3:* 57–67, 1948.

C. *Pernicious Anemia of Pregnancy*

1. Wills, L.: Studies in Pernicious Anemia of Pregnancy; Tropical Macrocytic Anemia as a Deficiency Disease, with Special Reference to the Vitamin B Complex. Indian J. Med. Res., *21:* 669–681, 1934.
2. Strauss, M. B.: Etiology and Treatment of Anemia in Pregnancy. J. A. M. A., *102:* 281–283, 1934.
3. Segerdahl, E.: Pernicious Anemia of Pregnancy; Clinical and Hematological Study. Acta. Med. Scandinav., *108:* 483–501, 1941.

D. *Exogenous Pernicious Anemia (or Extrinsic Factor Deficiency)*

1. Alsted, G.: Exogenous Pernicious Anemia. Am. J. Med. Sci., *197:* 741–750, 1939.

E. *Nutritional Macrocytic Anemia*

1. Groen, J. and Snapper, I.: Dietary Deficiency as a Cause of Macrocytic Anemia. Am. J. Med. Sci., *193:* 633–646, 1937.
2. Wills, L. and Evans, B. D. F.: Tropical Macrocytic Anemia: Its Relation to Pernicious Anemia. Lancet, *2:* 416–421, 1938.
3. Wills, L.: Pernicious Anemia, Nutritional Macrocytic Anemia, and Tropical Sprue. Blood, *3:* 36–56, 1948.

F. *Nutritional Pancytopenia*

1. Langston, W. C., Darby, W. J., Shukers, C. F., and Day, P. L.: Nutritional Cytopenia (Vitamin M Deficiency) in the Monkey. J. Exp. Med., *68:* 923–940, 1938.

G. *Sprue*

1. Castle, W. B. and Rhoads, C. P.: The Etiology and Treatment of Sprue in Puerto Rico. Lancet, *1:* 1198–1199, 1932.

2. Mackie, T. T., Miller, D. K., and Rhoads, C. P.: Sprue: Roentgenologic Changes in the Small Intestine. Am. J. Trop. Med., *15:* 571–589, 1935.
3. Castle, W. B., Rhoads, C. P., Lawson, H. A., and Payne, G. C.: Etiology and Treatment of Sprue; Observations on Patients in Puerto Rico and Subsequent Experiments on Animals. Arch. Int. Med., *56:* 627–699, 1935.
4. Hanes, F. M. and McBryde, A.: Identity of Sprue, Non-tropical Sprue and Celiac Disease. Arch. Ind. Med., *58:* 1–16, 1936.
5. Snell, A. M.: Tropical and Non-tropical Sprue (Chronic Idiopathic Steatorrhea): Their Probable Interrelationship. Ann. Int. Med., *12:* 1632–1671, 1939.

H. *Celiac Disease*
1. Parsons, L. G.: Celiac Disease (Rachford Memorial Lectures). Am. J. Dis. Child., *43:* 1293–1346, 1932.

I. *Idiopathic Steatorrhea*
1. Snell, A. M. and Camp, J. D.: Chronic Idiopathic Steatorrhea; Roentgenologic Observations. Arch. Int. Med., *53:* 615–629, 1934.
2. Thaysen, T. E. H.: Ten Cases of Idiopathic Steatorrhea. Quart. J. Med., (new series) *4:* 359–395, 1935.
3. Albright, F. and Stewart, J. D.: Hypovitaminosis of All Fat-Soluble Vitamins Due to Steatorrhea; Report of a Case. New England J. Med., *223:* 239–241, 1940.

J. *Kwashiorkor*
1. Suzman, M. M.: Clinical Aspects of Vitamin B Deficiency in South Africa. Clinical Proc., *1:* 205–231, 1944.

K. *Nutritional Gynecomastia*
1. Klatskin, G., Salter, W. T., and Humm, F. D.: Gynecomastia Due to Malnutrition. I. Clinical Studies. Am. J. Med. Sci., *213:* 19–30, 1947.
2. Salter, W. T., Klatskin, G., and Humm, F. D.: Gynecomastia Due to Malnutrition. II. Endocrine Studies. Am. J. Med. Sci., *213:* 31–36, 1947.

L. *Burning Foot Syndrome* (*Happy Foot Syndrome*)
1. Harrison, G. F.: Nutritional Deficiency, Painful Feet, High Blood Pressure in Hong Kong. Lancet, *1:* 961–964, 1946.
2. Simpson, J.: "Burning Feet" in British Prisoners-of-War in the Far East. Lancet, *1:* 959–961, 1946.
3. Glusman, M.: Syndrome of "Burning Feet" (Nutritional Melalgia) as a Manifestation of Nutritional Deficiency. Am. J. Med., *3:* 211–223, 1947.

M. *Nutritional Myasthemia Gravis of Prisoners of War*
1. Musselman, M. M.: Nutritional Diseases in Cabanatuon Camp. War Medicine, *8:* 325–332, 1945.

N. *Polyneuritis of Pregnancy*
1. Strauss, M. B. and McDonald, W. J.: Polyneuritis of Pregnancy; A Dietary Deficiency Disorder. J. A. M. A., *100:* 1320–1323, 1933.

2. Plass, E. D. and Mengert, W. F.: Gestational Polyneuritis. J. A. M. A., *101:* 2020–2023, 1933.

O. *Nutritional Polyneuritis*

1. Minot, G. R., Strauss, M. B., and Cobb, S.: "Alcoholic" Polyneuritis, Dietary Deficiency as a Factor in Its Production. New England J. Med., *208:* 1244–1249, 1933.
2. Strauss, M. B.: The Therapeutic Use of Vitamin B_1 in Polyneuritis and Cardiovascular Conditions. *In* The Vitamins, 193–202. Chicago. American Medical Association, 1939.
3. Walshe, F. M. R.: Aetiology of Polyneuritis. Lancet, *1:* 33–35, 1941.

P. *Nutritional Amblyopia (Including Central Scotoma and Retrobulbar Neuritis)*

1. Raman, T. K. and Abbu, C.: Lesions of the Optic Nerve in Vitamin B_1 Deficiency. J. Indian Med. Assoc., *10:* 417–422, 1941.
2. Wilkinson, P. B. and King, A.: Amblyopia Due to a Vitamin Deficiency. Lancet, *1:* 528–531, 1944.

Q. *Nutritional Disturbances of Cranial Nerves*

1. Spillane, J. D. and Scott, G. I.: Obscure Neuropathy in the Middle East; Report on 112 Cases in Prisoners-of-War. Lancet, *2:* 261–264, 1945.
2. Spillane, J. D.: Nutritional Diseases of the Nervous System. Baltimore. Williams & Wilkins, 1946.

R. *Generally Useful References*

1. Davidson, L. S. P. and Leitch, I.: Nutritional Anaemias of Man and Animals. Nutr. Abst. & Rev., *3:* 901–930, 1934.
2. Mackie, T. T. and Pound, R. E.: Changes in the Gastro-intestinal Tract in Deficiency States, with Special Reference to the Small Intestine: Roentgenologic and Clinical Study of 40 Cases. J. A. M. A., *104:* 613–618, 1935.
3. Spies, T. D., Vilter, R. W., and Ashe, W. F.: Pellagra, Beriberi and Riboflavin Deficiency in Human Beings: Diagnosis and Treatment. J. A. M. A., *113:* 931–937, 1939.
4. Golden, R.: Abnormalities of the Small Intestine in Nutritional Disturbances: Some Observations on Their Physiologic Basis (Carman Lecture). Radiology, *36:* 262–286, 1941.

IX. *SOME DISEASES SUSPECTED OF BEING IN PART RELATED TO MALNUTRITION*

A. *Darier's Disease*

1. Peck, S. M., Chargin, L., and Sobotka, H.: Keratosis Follicularis (Darier's Disease); A Vitamin A Deficiency Disease. Arch. Derm. & Syph., *43:* 223–229, 1941.
2. Peck, S. M., Glick, A. W., Sobotka, H., and Chargin, L.: Vitamin A Studies on Cases of Keratosis Follicularis (Darier's Disease). Arch. Dermat. & Syph., *48:* 17–31, 1943.

B. *Acne Rosacea*

1. Tulipan, L.: Acne Rosacea, A Vitamin B Complex Deficiency. Arch. Dermat. & Syph., *56:* 589–591, 1947.

C. *Hepatoses (Some Types, Including Alcoholic Cirrhosis)*

1. Patek, A. J., Jr.: Treatment of Alcoholic Cirrhosis of the Liver with High Vitamin Therapy. Proc. Soc. Exp. Biol. & Med., *37:* 329–330, 1937.
2. Connor, C. L.: Etiology and Pathogenesis of Alcoholic Cirrhosis of the Liver. J. A. M. A., *112:* 387–390, 1939.
3. Patek, A. J., Jr., and Post, J.: Treatment of Cirrhosis of the Liver by Nutritious Diet and Supplements Rich in Vitamin B Complex. J. Clin. Invest., *20:* 481–505, 1941.

D. *Wernicke's Encephalopathy*

1. Campbell, A. C. P. and Russell, W. R.: Wernicke's Encephalopathy; Clinical Features and their Probable Relationship to Vitamin B Deficiency. Quart. J. Med., *10:* 41–64, 1941.

E. *Purpura, Some Types*

1. Scarborough, H., and Stewart, C. P.: Effect of Hesperidin (Vitamin P) on Capillary Fragility. Lancet, *2:* 610–612, 1938.

X. *DISORDERS RELATED TO INGESTION OF SUBSTANCES, SOME TOXIC*

A. *Fluorosis*

1. Black, G. V. and McKay, F. S.: An Investigation of Mottled Teeth. Dental Cosmos, *58:* 129–156, 1916.
2. Smith, M. C., Lantz, E. M., and Smith, H. V.: The Cause of Mottled Enamel, a Defect of Human Teeth. Univ. Ariz. Ag. Exp. Sta. Tech. Bull., *32:* 253, 1931.
3. DeEds, F.: Chronic Fluorine Intoxication; A Review. Medicine, *12:* 1–60, 1933.
4. Dean, H. T.: Chronic Endemic Dental Fluorosis (Mottled Enamel). J. A. M. A., *107:* 1269–1273, 1936.

B. *Cobalt Polycythemia*

1. Barron, A. G. and Barron, E. S. G.: Mechanism of Cobalt Polycythemia; Effect of Ascorbic Acid. Proc. Exp. Biol. & Med., *35:* 407–409, 1936.

C. *Hypervitaminosis A*

1. Josephs, H. W.: Hypervitaminosis A and Carotinaemia. Am. J. Dis. Child., *67:* 33–43, 1944.

D. *Carotinaemia*

1. Stannus, H. S.: Hyperlipochromia; Carotinaemia, Xanthosis, Cutis. Internat. Clin., *1:* 146–163, 1929.
2. Almond, S. and Logan, R. F. L.: Carotinaemia. Brit. Med. J., *2:* 239–241, 1942.
3. Hoch, H.: The Effect of Prolonged Administration of Carotene in the Form of Vegetables on the Serum Carotene and Vitamin A Levels in Man. Biochem. J., *37:* 430–433, 1943.

E. *Hypervitaminosis D*

1. Thatcher, L.: Hypervitaminosis D. Lancet, *1:* 20–22, 1936.

2. Ross, S. G. and Williams, W. E.: Vitamin D Intoxication in Infancy. Am. J. Dis. Child., *58:* 1142–1143, 1939.
3. Freeman, S., Rhodes, P. S., and Yeager, L. R.: Toxic Manifestations Associated with Prolonged Ertron Ingestion. J. A. M. A., *130:* 197–202, 1946.

F. *Dicoumarol Poisoning*
1. Wright, I. and Prandoni, A.: Dicoumarin, 3,3′-methylene-bis-(4-hydroxycoumarin); Its Pharmacologic and Therapeutic Action in Man. J. A. M. A., *120:* 1015–1021, 1942.
2. Cahan, A.: Hemorrhage and Purpura Caused by Dicoumarin; Report of a Case. New England J. Med., *228:* 820–822, 1943.
3. Barker, N. W., Cromer, H. E., Hurn, M., and Waugh, J. M.: The Use of Dicoumarol in the Prevention of Post-Operative Thrombosis and Embolism, with Special Reference to Dosage and Safe Administration. Surg., *17:* 207–217, 1945.

G. *Lathyrism*
1. Anderson, L. A. P., Howard, A., and Simonsen, J. L.: Studies on Lathyrism. Indian J. Med. Res., *12:* 613–643, 1925.
2. Young, T. C. M.: A Field Study of Lathyrism. Indian J. Med. Res., *15:* 453–480, 1927.
3. Minchin, R. L. H.: Primary Lateral Sclerosis in South India; Lathyrism Without Lathyrus. Brit. Med. J., *1:* 253–255, 1940.

H. *Milk Intoxication*
1. Fehily, L.: Human-Milk Intoxication Due to B_1 Avitaminosis. Brit. Med. J., *2:* 590–592, 1944.

XI. *NUTRITIONAL DISTURBANCES RELATED TO INFECTION*

A. *Anemia of Infection with Diphyllobothrium Latum*
1. Bonsdorff, B. von: Pernicious Anemia Caused by Diphyllobothrium Latum in the Light of Recent Investigations. Blood, *3:* 91–102, 1948.

B. *Anemia of Chronic Infection*
1. Wintrobe, M. M. et al.: Anemia of Infection; Uptake of Radio-Active Iron in Iron-Deficient and in Pyridoxine-Deficient Pigs Before and After Acute Inflammation. J. Clin. Invest., *26:* 103–113, 1947.

C. *The Dysenteries*
1. Farah, N.: Enteric Fever Treated with Suprarenal Cortex Extract and Vitamin C Intravenously. Lancet, *1:* 777–779, 1938.
2. Manson-Bahr, P.: The Dysenteric Disorders; the Diagnosis and Treatment of Dysentery, Sprue, Colitis and Other Diarrheas in General Practice. Baltimore. Williams & Wilkins, 1939.

XII. *NUTRITIONAL DISTURBANCES RELATED TO INJURIES*

A. *Wound Healing*
1. Zintel, H. A.: The Healing of Wounds. Surgical Clinics of North America. Philadelphia. W. B. Saunders Co., 1946. P. 1404–1415.

B. *The Catabolic Reaction*
1. Browne, J. S. L., Schenker, V., and Stevenson, J. A. F.: Some Metabolic Aspects of Damage and Convalescence. J. Clin. Invest., *23:* 932, 1944.

BIBLIOGRAPHY

1. Adamson, J. D., Jolliffe, N., Kruse, H. D., Lowry, O. H., Moore, P. E., Platt, B. S., Sebrell, W. H., Tice, J. W., Tisdall, F. F., Wilder, R. M., and Zamecnik, P. C.: Medical Survey of Nutrition In Newfoundland. Canad. Med. Assoc. J., *52:* 227–250, 1945.
2. Adolph, E. F.: The Physiology of Man in the Desert. New York. Interscience Publishers, 1947.
3. Bean, W. B.: Cutaneous Arterial Spider; A Survey. Medicine, *24:* 243–331, 1945.
4. Berryman, G. H. and Chatfield, C.: A Short Method of Calculating the Nutritive Value of Diets. J. Nutrition, *25:* 23–37, 1943.
5. Berryman, G. H. and Howe, P. E.: A Short Method of Calculating the Nutritive Value of Diets (Concluded): J. Nutrition, *27:* 231–240, 434, 1944.
6. Bessey, O. A.: Proceedings of Conference on Methods of Evaluating Nutritional Status of Mothers, Infants and Children. Detroit, Michigan. Research Laboratory of the Children's Fund of Michigan, 1947, p. 53.
7. Borsook, H.: Effects of Vitamin Supplementation on Absenteeism, Turnover and Personnel Rating. Milbank Mem. Fund. Quart., *23:* 113–160, 1945.
8. Castle, W. B.: General Considerations in Vitamin Deficiencies. *In* Anaemias and Vitamin Deficiencies. Melbourne, Australia. Brown Prior, Anderson Pt., 1939. P. 101–119.
9. Crandon, J. H., Lund, C. C., and Dill, D. B.: Experimental Human Scurvy. New England J. Med., *223:* 353–369, 1940.
10. Dann, W. J. and Darby, W. J.: Appraisal of Nutritional Status (Nutriture) in Humans, with Especial Reference to Vitamin Deficiency Diseases. Physiol. Rev., *25:* 326–346, 1945.
11. Getz, H. R.: Nutrition and Tuberculosis. Nutrition Rev., *5:* 97–98, 1947.
12. Haldane, J. S. and Priestley, J. G.: Respiration. New Haven. Yale University Press, 1935.
13. Harris, Seale, and Harris, Seale, Jr.: Clinical Pellagra. St. Louis. C. V. Mosby Co., 1941.
14. Holt, L. E., Jr.: The B Vitamins and Certain Problems They Present to the Practicing Physician. Pennsylvania Med. J., *46:* 451–458, 1943.
15. Johnson, R. E., Darling, R. C., Forbes, W. H., Brouha, L., Egana, E., and Graybiel, A.: The Effects of a Diet Deficient in Part of the Vitamin B Complex Upon Men Doing Manual Labor. J. Nutrition, *24:* 585–596, 1942.
16. Johnson, R. E. and Kark, R. M.: Feeding Problems in Man as Related to Environment. Chicago. Quartermaster Food and Container Institute for the Armed Forces. 1946.
17. Johnson, R. E. and Kark, R. M.: Environment and Food Intake in Man. Science, *105:* 378–379, 1947.
18. Jolliffe, N.: Conditioned Malnutrition. J. A. M. A., *122:* 299–306, 1943.
19. Jolliffe, N.: The Clinical Signs of Malnutrition. Quarterly Bull., Dept. of Health, New York, June 1947.
20. Jolliffe, N. and Most, R. M.: Appraisal of Nutritional Status. Vitamins & Hormones, *1:* 59–107, 1943.
21. Keys, A., Henschel, A., Taylor, H. L., Mickelsen, O., and Brozek, J.: Experimental Studies on Man with a Restricted Intake of the B Vitamins. Am. J. Physiol., *144:* 5–42, 1945.
22. Kark, R. M., Aiton, H. F., Pease, E. D., Bean, W. B., Henderson, C. R., Johnson, R. E., and Richardson, L. M.: Tropical Deterioration and Nutrition. Medicine, *26:* 1–40, 1947.
23. Kark, R. M., Doupe, J., Aiton, H. F., and Pease, E. D.: Nutrition, Environment and Physical Fitness. J. Trop. Med. & Hyg., *49:* 103–107, 1946.
24. Kark, R. M., Croome, R. R. M., Cawthorpe, J., Bell, D. M., Bryans, A., MacBeth, R. J., Johnson, R. E., Consolazio, F. C., Poulin, J. L., Taylor, F. H. L., and Cogswell, R. C.: Observations on a Mobile Arctic Force. J. Applied Physiol., *1:* 73–92, 1948.
25. Kraut, H. A. and Muller, E. A.: Caloric Intake and Individual Output. Science, *104:* 495–497, 1946.
26. Kruse, H. D.: Medical Evaluation of Nutritional Status: IV. The Ocular Manifestation of Avitaminosis A, with Especial Consideration of the Detection of Early Changes by Biomicroscopy. U. S. Pub. Health Rep., *56:* 1301–1324, 1941.
27. ——: Medical Evaluation of Nutritional Status. Milbank Mem. Fund Quart., *19:* 207, 1941.

28. ——: The Gingival Manifestations of Avitaminosis C, with Especial Consideration of the Detection of Early Changes by Biomicroscopy. Milbank Mem. Fund Quart., *20:* 290–323, 1942.
29. ——: The Lingual Manifestations of Aniacinosis, with Especial Consideration of the Detection of Early Changes by Biomicroscopy. Milbank Mem. Fund Quart., *20:* 262–289, 1942.
30. Ladell, W. S. S., Waterlow, J. C., and Hudson, M. F.: Desert Climate, Physiological and Clinical Observations. Lancet, *2:* 491, 527, 1944.
31. Meiklejohn, A. P.: The Diagnosis and Treatment of Nutritional Deficiency. New England J. Med., *222:* 760–765, 1940.
32. Pijoan, M. and Lozner, E. L.: The Physiological Significance of Vitamin C in Man. New England J. Med., *231:* 14–21, 1944.
33. Schneider, H. A.: Nutrition and Resistance to Infection: The Strategic Situation. Vitamins & Hormones, *4:* 35–70, 1946.
34. Sebrell, W. H. and Butler, R. E.: Riboflavin Deficiency in Man (Ariboflavinosis). U. S. Pub. Health Rep., *54:* 2121–2131, 1939.
35. Stewart, C. B. and Manning, G. W.: Detailed Analysis of Electrocardiograms of 500 RCAF Aircrew. Am. Heart J., *27:* 502–523, 1944.
36. Stuart, H. C. and Meredith, H. V.: Use of Body Measurements in the School Health Program. Part I. General Considerations and the Selection of Measurements. Am. J. Pub. Health, *36:* 1365–1373, 1946.
37. ——, ——: Ibid. Part II. Methods to be Followed in Taking and Interpreting Measurements and Forms to be Used. Am. J. Pub. Health, *36:* 1373–1386, 1946.
38. Meredith, H. V. and Stuart, H. C.: Ibid. Part III. Supplementary Note Supplying Measurement and Rating Equivalents for Thickness of Skin and Subcutaneous Tissue Below Left Scapula and Above Left Ilium. Am. J. Pub. Health, *37:* 1435–1438, 1947.
39. Swanson, C.: The Differential Diagnosis of the Skin Manifestations in Pellagra from Other Dermatoses. South. Med. J., *9:* 117–123, 1916.
40. Sydenstricker, V. P., Geeslin, L. E., Templeton, C. M., and Weaver, J. W.: Riboflavin Deficiency in Human Subjects. J. A. M. A., *113:* 1697–1700, 1939.
41. Wetzel, N. C.: Physical Fitness in Terms of Physique, Development and Basal Metabolism. J. A. M. A., *116:* 1187–1195, 1941.
42. Wising, P. J.: Monosymptomatic Isolated Riboflavin Deficiency (Ariboflavinosis) in A Human Subject. Acta. Med. Scandinav., *116:* 288–293, 1944.
43. Wolf, S.: Effects of Attitude and Conditioning on Action of Chemical Agents in Human Subjects. The Pharmacology of Placebos. Proc. Am. Soc. Clin. Invest., 40th Annual Meeting, May 3, 1948. P. 45.

Section V

THE ROLE OF SURVEYS IN COMMUNITY NUTRITION PROGRAMS

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INTRODUCTION

Since the beginning of public health work it has been recognized that, to be effective, a plan of action must be based on the actual situations of community life. The survey constitutes the means for obtaining the facts which describe these situations. In the early years of "nutrition work" surveys were neither as extensive nor as elaborately organized as those mentioned in the preceding papers. To secure information the workers had to use whatever means were at their disposal. A "survey" might have been nothing more than an oral questioning of club members in a rural area, but the answers indicated the need for more home gardens. Or it might have been a cursory inspection of children's lunches brought from home which demonstrated the necessity for improving them. The facts obtained from such observations, however elementary, guided the early workers in formulating plans of action.

During recent years, with the expansion of community nutrition services, there has been an increasing interest in the nutritional survey and the techniques for conducting it. Both official and voluntary health agencies recognize that the data obtained will eliminate to some extent the opportunism which has characterized many nutrition programs by directing their work into the areas where there is the greatest need. After an interval of observation or endeavor, the survey may be repeated to check the original observations or to evaluate whatever attempt has been made to change or to modify the nutritional aspects of community health. The survey has the additional advantage of motivating action. It is a commonplace that people are interested in what applies to themselves as individuals or in work to which they have contributed. When a survey is made locally, members of a community usually participate either as subjects or as volunteers assisting the technical personnel, and quite naturally they are interested in the results. Considered solely from the standpoint of motivating action, the nutrition survey easily justifies itself.

In organizing the survey, there are several factors affecting the total food environment which are important to consider inasmuch as they will influence whatever action program is to be undertaken subsequently. In the previous papers, these factors have been considered in discussions of the selection of samples and the interpretation of results. They will be reconsidered as they relate to the content of this paper.

The *season of the year* may cause a wide variation in diets for a given area. Data obtained in the early fall when garden produce is abundant and cheap usually give a very favorable picture, especially for people living on farms and in small towns. However, if the survey is repeated in the late spring, the diets may show marked inadequacies. The *geographical location* determines in part what foods are available in a given market. Accessibility to railways or highways influences the amount of food imported by a given community. A survey of food supplies or practices in one area of a county or state may be of little use in planning a program in another area unless the same variety of foods is available in each. Any given *occupational group* may have its individual food practices which will require special consideration in planning a community program. If the dietary findings from such a specialized group are included with those for the total working population, then the particular needs of that group may be overlooked. The same observation may be made with reference to the presence of one or more *national groups* in the sample. A school in one of the border states could have children of both Mexican and American parents, with each group adhering to its traditional diet. If the dietary records for both groups are reported in one set of figures, neither dietary pattern will be properly evaluated and the results will be misleading. An educational program based on such erroneous data will not be realistic and can result only in failure.

A nutrition survey of a community must also take into account the *economic status* of the subjects. Buying power determines to an appreciable extent the possibility of obtaining an adequate diet. The data of a survey are more useful if they are reported for several levels of income. A survey may also be concerned with the dietary practices of groups which are more or less homogeneous with respect to their *physiological status*, i.e., children in the primary school or adolescent boys and girls. If data are obtained from these sub-groups, an educational program prepared for their benefit will be adapted to the physiological needs and the psychological capacities of the group in question.

A detailed description of the *cultural environment* of the survey subjects is useful in modifying the approach and content of a nutrition program. Some of the techniques used by the social anthropologists in collecting data on attitudes toward food could with profit be incorporated in a survey of dietary practices.

TYPES OF SURVEY

There are several types of survey which are applicable to the purpose of determining community needs. The selection of the one to be used will depend on the nature of the information desired and on the facilities and funds available. The following types of survey will be discussed:

1. The survey of nutrition services available in a community.

2. The survey of food supplies.
3. The survey of dietary practices.
4. The survey of factual knowledge of nutrition.
5. The survey of the nutritional status of individuals (by physical examination and chemical tests).
6. The survey to evaluate educational methods.

1. *The survey of nutrition services available in a community.*—When a local group or agency wants to organize a nutrition service, the preliminary step in planning should be a careful review of the nutrition activities already existing in the community. If it is done properly, such a review will be, in effect, a survey. The advisory committee of the agency may appoint a subcommittee with both lay and professional representation to be responsible for the survey. The objectives will be to appraise the worth of current activities in the field of nutrition, to eliminate overlapping services, and to disclose unmet needs. During the war, the American Red Cross developed a form entitled "Survey of What Your Community Is Doing for Better Nutrition" to assist its chapters in planning their nutrition programs (1). While the items of the form refer to agencies and activities current in 1942, it is still useful as a list of community enterprises which should be appraised before a new program is undertaken.

Occasionally, the large urban centers invite a specialist to study their resources in the fields of health and welfare. A thorough-going review of the activities of all agencies usually covers those pertaining to nutrition. The recent "Survey of Health, Welfare, and Recreation Needs and Services of Springfield, Massachusetts" (2) directed by Dr. C. E. A. Winslow, includes an evaluation of the nutrition program in the Springfield area as related to the total health needs of the community.

2. *The survey of food supplies.*—The discussion here is limited to the crude survey which could be undertaken by a local nutrition committee or even a student group working under the leadership of a trained person, i.e., health officer, extension agent, nutritionist, or teacher. Even though it gives only a rough approximation of the condition of the local food supply, such a survey is useful in keeping the planning of a community program within the realities of a local situation.

A survey of food supplies may be concerned both with the quantity of food available for consumption and with its quality. Roughly, the quantity is equal to the food grown locally plus the food imported, minus that which is exported. This quantity may be compared with the amounts which would be required if each person in the community were to receive, for example, a minimum adequate diet. Or the quantity of available food may be divided by the number of consumer units. If the supply of any nutritionally important food appears to be insufficient, the reasons can be investigated and whatever educational program is in progress or in the planning stage will take account of the shortage. An adequate supply of a particular food does not mean that it will be equally distributed among all the members of the community. The distribution will be determined by differences in buying power and by individual preferences.

A rough check on how the food supply is being distributed throughout a given population may be made by a survey of buying practices in the different parts of

the area. By consulting the food dealers, it is possible to learn not only what nutritionally important foods are purchased in a given district but how these purchases are affected by price changes. This kind of survey repeated periodically by volunteers can furnish rough data which will keep an educational program in line with the actual food situation.

A survey of the food supply in a food-producing area may include information on the disposition of surplus foods. If the surpluses are being wasted and either education or concerted action is the answer to a more efficient utilization, then a problem is posed for the nutrition service of that community. It frequently happens that nutritionally important foods are exported in quantities that leave the community with an insufficient supply, or occasionally such foods are turned to non-food uses. Whatever group is planning a community nutrition program should be aware of these facts.

The sources of information regarding the quantitative aspects of the food supply will vary in different communities. Wholesale and retail grocers, the dairy companies, the county extension agent, the Chamber of Commerce, and the State departments of agriculture are some of the agencies which can furnish pertinent facts.

Data describing the quality of the food supply are obtainable from at least two sources: the State or local departments of health, and the colleges and universities in the area. The health departments, both of the State and of the district, are responsible for the enforcement of ordinances which regulate the sanitation of milk and food. They have information regarding the quality of the milk supply and the sanitary aspects of food handling. The laboratories of the State colleges and universities usually have projects for investigating the nutritive quality of foods grown locally. Soils, climatic conditions, and the varieties of a particular species of food will modify nutritive values, and the degree to which these values differ from those in the standard food table should be taken into account in planning the subject matter to be used in the nutrition program of a given community.

3. *The survey of dietary practices.*—A survey of dietary practices may be made in several ways. It may consist of an investigation of the food practices of individuals or of a group of individuals eating together as a group, such as the family. Or it may be a description of the folkways of preparing and valuing food with no consideration for the behavior of individuals. The section on "Dietary Surveys and Their Interpretation" has defined the principal types of dietary survey. The contribution of this paper will be to present a few additional comments with a relisting of the various forms in order to clarify the ensuing discussion.

a. *Individual dietary history.*—A dietary history includes an account of the foods usually eaten during the course of the day, recorded in meal patterns and between-meal feedings. This is cross-checked with a report of the amounts and frequency with which each of the different food groups are used habitually (3). The history is supposed to approximate the typical food intake over a given period of time. Supplementary information is also obtained regarding social, environmental, economic, and psychological factors which may influence the individual's food habits. For this purpose, questions are asked about occupation, place where meals are eaten,

facilities for food preparation, expenditures for food, and food preferences and aversions and the reasons for them.

The term nutritional history is often used interchangeably with dietary history. However, a nutritional history should represent a physical and biochemical appraisal of the nutritional status of the individual, combined with a dietary history.

b. *Individual food intake record.*—In public health practice the food intake record consists of a report of the food eaten either for the whole day or for a given meal as at breakfast or lunch. It may be furnished by the subject, who has been given a specially prepared form and instructions for reporting kinds and amounts of food eaten. The food record may also be obtained by a trained worker through an interview with the subject. In these two cases the food record is only an approximation of the amounts of food eaten. For a more accurate record the subject may be asked to weigh out all the food eaten or the investigator may do it for him. This procedure increases to a considerable extent the accuracy of the report by furnishing more exact information regarding amounts. However, it is a tedious procedure and requires some selection of subjects in order to find cooperative ones. It also creates an artificial situation in that the individual may eat more or less than desired to save himself the trouble of weighing the food.

Food intake records may be kept for one, three, seven, or more days at a time. As a matter of fact, there is at present no agreement among investigators as to the number of days which can give a representative picture of the typical food intake. There is good argument for repetition to eliminate the effect of seasonal variations. It is generally agreed that children under ten or eleven years of age are not usually satisfactory subjects. They cannot remember all that they have eaten nor can they record amounts of food with any degree of accuracy.

The findings from food intake records may be evaluated in two ways:

(1) Qualitative: a record of the intake of food groups, i.e., green leafy vegetables, citrus fruit, milk, etc.

(2) Quantitative: a determination of the nutritive value, i.e., number of calories, grams of protein, etc., either by actual analysis or by calculation using food tables.

Usually the first method is preferred. There is some controversy about the advisability of applying the second method to the evaluation of the data other than the weighed intake record, since there is always a question of the accuracy of the reports of the food eaten.

c. *Family or institutional dietary surveys.*—This type of survey of food practices has been adequately discussed in the section on "Dietary Surveys and Their Interpretation." The following comments refer to the practicability of this type of survey as a means of determining the dietary practices of a sample of the community.

For purposes of planning a community nutrition program, a survey of food practices should be planned to furnish information on methods of food preparation and the prevalent attitudes toward specific foods. A study of this nature usually is not undertaken as a separate project. The social anthropologist includes such observations in his study of a particular cultural group. The nutrition worker may obtain these data in conjunction with the dietary history or the food purchase study.

An investigation of food preparation methods will bring to light practices and prejudices which may be salutary or detrimental to good nutrition. A survey of food practices of families in Lubbock, Texas (4) disclosed the rather general use of "pot liquor." This is a desirable practice since the water in which vegetables are cooked often contains significant amounts of minerals and vitamins. Or the information obtained from diet histories may disclose a general custom of overcooking of vegetables or the soaking of foods "to remove poisons," practices whose correction will need to be taken into account in planning an educational program.

Different cultures or sub-groups within a given culture may have specific attitudes toward foods. For instance, among some groups milk may be considered a food solely for children, most of the meat allowance may be saved for the working man, the use of dark bread may be a measure of social status, etc. The "Manual for the Study of Food Habits" (5) is a guide for those workers who wish to plan surveys which take into account the social and cultural factors determining food practices.

4. *The survey of factual knowledge of nutrition.*—The survey of factual knowledge may have two purposes: 1) to determine the content of subject matter to be used in a particular situation; 2) to measure the effectiveness of a method in presenting facts. Before planning the content of class material or of audio-visual aids for use with a given group (housewives, industrial workers, etc.) it is advisable to know the extent to which the group is familiar with the principles of nutrition and their application in the choice of food. Questionnaires, quizzes, true and false or multiple choice tests are frequently used to get the information. The repetition of a test serves as a means of measuring the effectiveness of a particular technique in conveying facts. The results may also indicate a need for modifying either the subject matter or the method of presentation. Tests of factual knowledge usually stimulate an interest in the subject matter of nutrition but they cannot be considered a reliable index of the degree to which knowledge has influenced nutritional behavior.

5. *The survey of nutritional status of individuals.*—This type of survey has been ably discussed in the preceding sections. Few communities have the facilities or funds for making such detailed medical and biochemical studies. However, physicians can include in the routine physical examination some few items which have significance in appraising the nutritional condition of the individual patient. If this were done, a review of the case records in health centers, hospitals, schools, and the offices of private practitioners would give a clue to the incidence of some nutritional syndromes in the community.

6. *The survey to evaluate educational methods.*—A survey may be used to measure the effectiveness of a specific educational technique or a combination of several. To evaluate one or more techniques, a preliminary survey must be made. Any one of the types of survey previously discussed may be used, i.e., a study of food supplies, dietary practices, factual knowledge of nutrition, or nutritional status of a group of individuals. Then one or more educational methods are introduced to the community or to a selected group within it. After a given period of time the same survey is repeated. Any change in dietary knowledge, attitudes, practices, or nutritional status may be interpreted, with reservations, to be the result of the educational activities. Applying this procedure to test the effectiveness of one special technique

is practically impossible even under well controlled conditions, for too many factors are involved. For instance, if one wishes to know the effectiveness of a pamphlet, poster, or talk, it would be difficult to rule out the effect of other factors, such as the radio, talks with neighbors, or magazine articles, to which the individual may have been exposed during the same period.

EXAMPLES OF SURVEYS

The authors have reviewed several nutrition and dietary surveys done in the United States over a period of 30 years. Dating from the earliest papers of Goldberger to the present time, the surveys fall into two categories. For the first 20 years they were concerned almost solely with food consumption. A large number of surveys, published in bulletins of the agricultural experiment stations, have to do with the dietary practices of families living in rural areas. Beginning in the late thirties and especially during the present decade the surveys have assumed a different character. Now the greater number are concerned with investigating the prevalence of nutritional deficiencies by physical and biochemical methods and with determining their relationship to the dietary practices of the people.

If these surveys are considered with regard to remedial or preventive programs based on the findings, the results are surprisingly small. It could be concluded on the basis of published reports that almost no surveys disclosing unfavorable conditions were followed by an educational program designed to remedy them. In spite of the lack of printed evidence, it is common knowledge among community workers that this is not always the case. The surveys made by the agricultural experiment stations often were used by the extension agents in planning programs of food production for the farmer, or they served as a guide for education of the farmer's wife in food selection, menu planning, etc. Or we can consider the studies which relate the pregnant woman's diet to her obstetrical course and to the condition of her infant at birth and during the neonatal period. Even though the correlation between a poor diet and an unfavorable obstetrical course is not invariably a positive one, nevertheless the results of these studies have aroused a general concern among clinicians to the point where dietary advice for the pregnant woman is coming to be considered an essential part of good prenatal care. The public health agencies have drawn heavily on these studies and surveys in planning their prenatal services and in preparing educational material dealing with the diet during the prenatal and lactating periods.

A similar observation could be made of the surveys of the nutritional condition of children in relation to their food intake. While no mention is made of how the resulting data have been applied, it is known that school systems, health agencies, and commercial concerns have used the data in planning programs of nutrition education for children.

Following are a few examples of surveys in which it is implied or stated explicitly that the data were used in some manner as the basis for a program for nutritional improvement.

One community has used a survey of food purchases as the means of evaluating its nutrition education program. Young (6) reports the cooperation of 16 wholesale

food concerns and 98 retail grocers of Richmond, Virginia, in replying to questionnaires which asked for information regarding the sales of protective foods. Volunteers from the Housewives' League distributed the questionnaires before the beginning of the nutrition education program and again 6 months later. An experimental area was selected and the rest of the city served as a control. Although there was a city-wide gain in the sales of protective foods during the 6-month period, it was more marked in the experimental area where considerable individual and group instruction in nutrition had been given.

The use of the dietary survey to arouse interest in community nutrition programs is described by Feldman and Kaiser (7). The survey was planned and completed by the nutrition committees of 21 counties in Illinois. Two types of survey form were used. One was a 24-hour food record, the second a 1- to 7-day check list of "basic seven" foods. Both were filled out by groups of school children. The results proved to the cooperating communities that there was a great need for nutrition education. They also demonstrated which foods were most often lacking in the diet. At the time this article was published, one county repeated the survey as a means of evaluating the results of an intensive nutrition program. An increased consumption of all the "basic seven" foods except meat, fish, poultry, and potatoes was reported. In addition, the findings were useful to the State and county nutrition committees in planning their program of work. "A Suggestive Guide for Teaching Nutrition in Illinois Elementary Schools" was prepared by the State committee and distributed to the schools by local groups. Special emphasis was placed on coordinating the nutrition program in the schools with a similar one for adults.

In New York City, Downes and Baranovsky tested the effect of nutrition teaching by the public health nurses on the food habits of 60 tuberculous families in the Harlem area (8). They made a preliminary survey of the consumption of protective foods during a 7-day period and the amount of money spent for food by each of the families. The same record was obtained subsequently at monthly intervals over a total of 6 months; meanwhile, the nurses were giving special nutrition instruction to the families. A year after the special teaching began, the families were revisited. The workers found a significant increase in the use of protective foods. It was concluded that this special nutrition teaching was a feasible plan for programs of public health nursing and that it accomplished noteworthy results.

The Food Supply Division of the Institute of Inter-American Affairs is responsible for an interesting study, "Paraguayan Rural Life—Survey of Food Problems" (9). This survey was conducted in the Piribebuy area of Paraguay. It considers the total factors which may influence the nutritional condition of a people—its history, climate, geography, racial stock, soil condition, culture, etc. Reh, who supervised the study, used an adaptation of the food record method described by Stiebeling for surveying the dietary practices of families. Recipes were carefully compiled as to ingredients and manner of preparation. The report describes taboos on food, their prestige values, and what foods are used especially for festive occasions. The collection of data concerning the total food environment is worthy of note. If this method were used more often by investigators, it might result in a much-needed respect for dietary folkways. From this study of the area, the inhabitants, and

their food practices was drawn a suggested program for improving the food supply and for educating the people in its proper use.

There are some excellent studies to illustrate the use of the dietary survey in planning for nutrition teaching in primary and secondary schools. Bosley (10) reports using a 3-day record of food consumed by 9- to 11-year-old children as a basis for determining the kind of information to be taught. A similar study by Lockwood (11) takes into account the seasonal fluctuations in food intake by obtaining records at three different intervals during the school year. As a part of a research project in nutrition education, Whitehead (12) collected 7-day food records and made an evaluation of the adequacy of the diets. McHenry (13) obtained some valuable data on the health status and food habits of school children in a suburb of Toronto. A thorough medical examination, a dental inspection, records of food intake for 7-day periods, a questionnaire on food likes and dislikes, and a home visit to determine health conditions were all parts of the study. The data emerging from these surveys constituted the foundation for planning teaching units based on children's needs; the same data were used as groundwork for programs of in-service training of teachers. Moreover, since the general dietary pattern of a group of school children probably reflects the food habits of their families, the results of these surveys also were used in concurrent programs of nutrition education for adults.

The school lunch may serve as a means for studying the incidence of undesirable food habits and the extent to which they may be corrected by education. Some years ago the National Dairy Council made a survey of the lunches eaten by the children in a school cafeteria in Akron, Ohio (14). Only 8 per cent of the children had lunches which were considered nutritionally adequate. At the end of a 7-month program of teaching nutrition in the school, the percentage was increased to 72.

Vaughn (15) used a questionnaire as a means of surveying the nature of the facts about foods and nutrition which were known to a group of mothers attending a well child conference. On the basis of the answers, she planned a series of exhibits illustrating simple nutritional principles. The mothers were divided into experimental and control groups and the exhibits were presented at the conferences attended by the former. After an interval both groups were retested. The answers given by the mothers in the experimental group showed that the exhibits had been effective as a means of presenting facts.

Evaluation of a general program of nutrition education or of a specific method has been implicit in several of the surveys cited above (6, 7, 8, 15). There are a few examples of surveys set up definitely for the purpose of evaluating certain educational techniques. Radke and Klisurich (16) made a preliminary survey to determine the amount of milk, both fresh and canned, being used weekly by a group of housewives of low income level. The next step was to provide half the group with a lecture on nutrition which emphasized the role of milk in the well-balanced diet. The other half of the group participated freely in a discussion on the same subject and resolved by a unanimous vote to include more milk in the family diet. Follow-up surveys were made at intervals of two and four weeks. The individuals who had participated in the group decision were using more milk than those who had listened to the lecture. Radke and Caso (17) made a survey of the lunches eaten at school by a large group

of junior high school pupils. The same educational techniques of lecture and discussion-decision were tested. The classrooms where the discussion-decision method was tried showed the most marked improvement in their lunch habits.

A publication of the Bureau of Agricultural Economics entitled "Homemakers' Acceptance of Nutrition Information in an Urban Community" (18) is an important contribution to the study of the effectiveness of educational programs as measured by levels of nutrition information. It reports the results of 400 personal interviews with housewives. The survey of levels of nutrition information was compared with a similar survey made four years earlier. The results indicated "that no larger proportion of homemakers has adequate information now than in 1943." The second part of the survey was concerned with analyzing the effectiveness of various media used in the dissemination of nutrition information and the third part with ascertaining the motivating factors which can be used in educational programs to promote a wider use of information on foods and nutrition among homemakers. Most homemakers said they got more of their ideas on food and nutrition from newspapers and magazines than from radio, pamphlets, or classes. They also said that a wider use of nutrition information could be motivated by pointing out that the foods they should eat are important for health, for stamina and longevity, and for the growth of their children.

A detailed "Guide" for community nutritionists is available (19). It was prepared at the request of community nutritionists and consists of a compilation of specific suggestions concerning community nutrition programs. It considers problems of organization, administration, and techniques as they relate to community nutrition programs. It also discusses types of nutrition surveys applicable to the community.

CONCLUSION

Nutrition surveys are helpful in planning community educational programs. There are many types of survey which may be used, depending on the information desired and the facilities, personnel, and funds available for making the survey. All have as their ultimate aims to ascertain need, to suggest corrective measures, to motivate the community to action for improved health, and to aid in the periodic evaluation of the program.

BIBLIOGRAPHY

1. Survey on What Your Community Is Doing for Better Nutrition, Supplement No. 13, The American National Red Cross, October, 1942.
2. Survey of Health, Welfare and Recreation Needs and Services—Community Chest Area—Springfield, Massachusetts; Section II. Protection and Promotion of Health. Community Council, Springfield, Mass.
3. Burke, B. S.: The Dietary History as a Tool in Research. J. Am. Dietetic Assoc., *23:* 1041–1046, 1947.
4. Drake, P., and Lamb, M. W.: Study of the Dietary and Food Practices of 63 Families in Lubbock, Texas. J. Am. Dietetic Assoc., *20:* 528–529, 1944.
5. Manual for the Study of Food Habits. Bull. 111, Committee on Food Habits, National Research Council, Washington, D. C., 1945.

6. Young, A.: A Method for the Evaluation of a Community Nutrition Program. J. Am. Dietetic Assoc., *19:* 420–427, 1943.
7. Feldman, A. Young, and Kaiser, G.: Diet Surveys to Revive Nutrition Programs. J. Home Ec., *38:* 517–519, 1946.
8. Downes, J., and Baranovsky, A.: An Experiment in Nutrition Teaching by Public Health Nurses. Milbank Mem. Fund Quart., *23:* 227–253, 1945.
9. Paraguayan Rural Life—Survey of Food Problems, Food Supply Division of the Institute of Inter-American Affairs, Department of State, Washington, D. C., 1946.
10. Bosley, B.: A Practical Approach to Nutrition Education for Children. J. Am. Dietetic Assoc., *23:* 304–309, 1947.
11. Lockwood, E.: Nutrition Education in the Elementary Schools. Doctorate Dissertation, Harvard School of Public Health, Boston, 1948.
12. Whitehead, F. E.: Research in Nutrition Education. J. Am. Dietetic Assoc., *23:* 310–317,1947.
13. McHenry, E. W.: A Research Project in Health Education. J. Am. Dietetic Assoc., *24:* 9–11, 1948.
14. Chaney, M. S., and Ahlborn, M.: Nutrition. 3rd Ed. Houghton-Mifflin Company, 1943, pp. 357.
15. Vaughn, M. E.: The Effectiveness of Visual Education in Teaching Nutrition to Mothers in a Well-Baby Conference. Master's thesis, Harvard School of Public Health, Boston, 1945.
16. Radke, M., and Klisurich, D.: Experiments in Changing Food Habits. J. Am. Dietetic Assoc., *23:* 403–409, 1947.
17. Radke, M., and Caso, E. K.: Lecture and Discussion-Decision as Methods of Influencing Food Habits. J. Am. Dietetic Assoc., *24:* 23–31, 1948.
18. Homemakers Acceptance of Nutrition Information in an Urban Community. U. S. Dept. of Agriculture, Bureau of Agricultural Economics, Washington, D. C., 1948.
19. Thaw, Sophie Gordon and Caso, Elizabeth K.: A Guide for Community Nutritionists. New York. The Nutrition Foundation, Inc., 1947.

Section VI

NUTRITION SURVEYS IN RELATION TO PROFESSIONAL TRAINING IN SCHOOLS OF MEDICINE AND PUBLIC HEALTH

The important role assigned to nutrition in public health (The Nutrition Foundation, 1943; Smith, 1944; Stare, 1947) has led to an increasing demand for properly trained workers. The recognition of this need has resulted in a statement of the educational qualifications of nutritionists in health agencies (Committee on Professional Education of the American Public Health Association, 1946). Similar recognition of the importance of nutrition in medicine has given rise to calls for the incorporation of increased instruction in the subject in the medical curriculum (Wilder, 1943; Editorial, 1947). The needs and training of professional personnel in nutrition have also been considered by the Section on Professional Education in Nutrition of the National Nutrition Conference for Defense (1941), by the Technical Committee on Nutrition and Food Management of the United Nations Interim Commission on Food and Agriculture (1945), and by Davidson (1947). Despite this wide recognition of need, no single formula has evolved for the training of nutrition personnel.

The nutrition survey has great value as a teaching device. It is useful from this standpoint at both the professional and non-professional levels. The purpose of this chapter is to discuss the usefulness of the survey method in the training of professional workers. It is not implied in this discussion that the survey affords complete experience for these workers, but rather specific examples will be cited to demonstrate that it may be a useful tool in training programs.

The over-all nutrition survey deals with clinical, laboratory, and dietary measures. It, therefore, brings into close association workers with backgrounds in clinical medicine, biochemistry, dietetics, home economics, and, often, social service, nursing, or health education. It is inevitable that there should be great exchange of ideas among these workers who have been brought together into a survey team. This association within the team for a period of months results in a broadened understanding of the problems encountered within the population and a sounder appreciation of the many aspects of these problems.

For the training of public health personnel, such as nutritionists, health educators, and nurses, an experience with a nutrition survey is of unusual benefit. It is of especial value if it occurs within the region in which the individual is to be responsible for corrective measures, for through such training the worker secures first-hand knowledge of the dietary habits, prejudices, and customs, as well as living conditions, of the population. In addition he learns of the local agencies within the area which are concerned with food production, preservation, and education, as well as the degree of community organization, the status of medical and dental care in the region, and many other useful attributes of the region. Such first-hand experience prepares workers at all levels for a more critical evaluation of the problems which are encountered. It enables them to appraise the reasons for the existence of certain

dietary conditions and permits them to seek the proper assistance in instituting corrective programs. For example, if the milk supply of a town is insufficient to meet the demands of an adequate school-lunch program, the properly trained nutritionist will not immediately institute a campaign to induce the school child to drink unobtainable milk. Instead, his attention will be directed at the problem of increasing the available supplies from the milk-shed or toward obtaining an acceptable substitute, such as powdered milk, for the school-lunch program. The exact course which will attain the desired end will depend upon the many attributes of the community, and the intimate knowledge derived from the survey should prove useful in deciding upon the program to sponsor.

In addition to this over-all viewpoint which the nutrition survey affords, it provides students in schools of public health with an opportunity to observe examples of clinical deficiencies—an opportunity often denied students in those schools which are not intimately connected with schools of medicine. Simultaneously, it develops an understanding of the value and limitations of various criteria of deficiency.

Finally, repetitive studies upon a population group permit an objective measure of the effectiveness of nutrition teaching programs and, thereby, the adoption of the better methods. One example of this use of a dietary survey is that presented by Downes (1943) and Downes and Baranovsky (1945) who studied the alteration of dietary habits by Negro families following various degrees of emphasis upon nutrition in the teaching program of the public health nurse. Another example of a similar use of the nutrition survey is a study by Moser (1945) on the nutritional condition of children in two communities in South Carolina. In this investigation the effect was measured of provision of a school lunch upon the total dietary intake of the children. Among other findings, it appeared that in one community most families expected the newly provided "complete noon lunch" to substitute for the main meal of the day (previously taken in the evening). The importance in teaching of knowledge of such reactions of the community is obvious.

The summarized findings from surveys should serve as source material for planning group nutrition programs aimed at education of the non-professional nutrition workers, such as Red Cross groups, nutrition committees, county and home demonstration agents, teachers, and others. The education of these persons is often the direct or indirect responsibility of Schools of Public Health, the graduates of which may be called upon to organize training programs for non-professional workers. An example of the employment of data from nutrition surveys in such programs may be cited: In 1945, the Tennessee-Vanderbilt Nutrition Project summarized as follows the more tangible nutritional problems as revealed by the surveys made in the State.

"1. Obesity in adults, especially among women. This is primarily due to excessive intake of calories.
2. Substandard weights in some groups of children up to 15 years of age. In part, a reflection of caloric undernutrition, especially related to lack of breakfast.
3. Poor quality school lunches carried from home or served in some schools. These are often deficient in quantity as well as quality.
4. Iron deficiency in children under 2 years of age who are fed on milk alone. Iron deficiency type of anemia in some groups of women, occurring especially at the menopause and shortly

after delivery. Education should be directed toward the importance of prevention by seeking proper medical care.

5. Low protein intake by some farm families, by some school children, and by some pregnant and lactating women.
6. Low intake of vitamin C, riboflavin, and calcium by a portion of the lactating mothers.
7. Poor dental status of school children. This is a reflection of many factors, nutritional and non-nutritional. Some of the former may be the excessive use of sugars, candies, cold drinks, etc. The failure to recognize the importance of adequate dental care for deciduous teeth is probably of great importance in this problem."

This summary served as a guide for points to be emphasized in the teaching program carried out by the nutrition consultants of the State Health Department and also served as material for program planning by the State Nutrition Committee. A copy of it was incorporated in the Agricultural Extension Service Program which was provided the various community clubs. The nutrition programs of these clubs were then built around the solutions to the problems which the nutrition surveys had revealed. Most recently this summary has been incorporated in a newly prepared manual of health education for Tennessee schools, a manual sponsored jointly by the Department of Education and the Tennessee Department of Public Health. The wider employment of data from local surveys in a manner similar to this should result in much sounder and more convincing teaching programs. Illustrative data taken from the local study and properly interpreted to community groups may serve as basic material for non-professional training in community nutrition. The professional nutrition worker with an understanding of surveys is much better qualified to undertake these tasks.

Excellent field experience for personnel-in-training is provided by the more direct and individualized instruction of lay groups which almost invariably occurs during a nutrition survey. In order to secure local support of the survey, the survey team arouses the community consciousness of nutrition by means of talks to local clubs, community groups, medical societies, schools, and other agencies. Upon completion of the survey, the team has a definite obligation to report its findings to the community through these same media and to interpret them in terms of practical remedial measures. Finally, to the individual subjects who have participated, a complete report of the various studies made must be given either directly or through the subject's physician. The resulting education of individuals may be very effective.

Nutrition surveys which are limited to special groups, in contrast to those among the general population, may serve as catalysts for the development of a sound nutrition interest within medical schools. As an example of this type of development the experience at the School of Medicine of Vanderbilt University may be cited. During the years 1939–1941, the Departments of Medicine and Biochemistry collaborated in a series of nutrition surveys (Youmans *et al.*, 1943, '44, '45) within the general population. These were carried out under the direction of Doctor John B. Youmans. In 1943, these studies became a joint undertaking of the Tennessee Department of Public Health and of Vanderbilt University and continued to operate as such until July 1, 1947. In 1945, largely as a result of this continuous interest in nutrition surveys, five departments of the Medical School (Department of Preventive Medicine and Public Health, Department of Obstetrics and Gynecology, Depart-

ment of Pediatrics, Department of Medicine, and Department of Biochemistry) joined in an intensive nutrition survey of the women attending the prenatal clinic and of the infants born to these mothers. This study, known as the Vanderbilt Cooperative Study of Maternal and Infant Nutrition, has been under way for a period of 2 years and is expected to continue for an additional 3-year period. Members of each of the departments named are participating actively in the study. This participation has brought about within these groups an increasingly widespread consciousness of the role of nutrition in the preservation of health as well as in diseased states. It has served as a stimulus to all of the cooperating investigators to study and appraise the potential and latent zones of nutritional deficiency as well as the clinically manifest diseases. Further, as a result of the interest in this cooperative study, some of the personnel of the cooperating departments have now undertaken independent investigations of nutritional diseases encountered within their field of specialization. Finally, in considerable part as a result of these two types of nutrition surveys, the special project previously sponsored jointly by the Medical School and the State Health Department has now been established as a permanent Division of Nutrition in the Departments of Biochemistry and Medicine of this Medical School. Although not all such surveys will result in such permanent developments within cooperating schools, they cannot fail to stimulate an increased interest in nutrition among the associated personnel.

In addition to these broader aspects of personnel training, the nutrition survey is peculiarly well adapted to provide training in methodology. This technique offers an ideal opportunity for training in the statistical approach to a problem, a discipline in which too few nutrition investigators have been versed in the past. This training in statistics is best secured by enlisting the cooperation of a biostatistician at the stage of preliminary planning of a survey and then working throughout the investigation and the processing of data in collaboration with the statistician (Muench, 1945, '47). As examples of studies which have been carried out in this manner may be cited the series on California aircraft workers (Wiehl, '42; Borsook, '45; Borsook and co-workers, '46; Borsook, Alpert and Keighley, '43; Borsook and Wiehl, '46) and the Vanderbilt Cooperative Study of Maternal and Infant Nutrition (to be published).

The ideal nutrition survey affords an unexcelled opportunity to the biochemist for an experience in critical scrutiny and standardization of laboratory methods. The literature of biochemistry and nutrition abounds with methods (some of them are widely employed) concerning which no quantitative statement regarding errors and variability have been presented. Most nutrition surveys have not improved this situation; a few, however, are noteworthy in their contributions in this direction. One of the best examples of the detailed study of the sources and magnitude of errors in a chemical procedure, the variability of the procedure, and the standardization of it, is given by the Committee on Hemoglobin Surveys of the Medical Research Council of Great Britain (1945). An experience with such an analysis would be an invaluable part of the training of a biochemist or physiologist. Somewhat similar analyses of the sources of error in another hemoglobin technique (Wiehl, 1946), as well as in a method for ascorbic acid (Wiehl and Kantorovitz, 1942; Beebe, 1942),

have been provided. Development and extension of these approaches associated with the nutrition survey should provide a reservoir of personnel who are much better equipped to design and execute scientific investigations and to plan and evaluate health procedures (Muench, 1947).

The use of the many laboratory methods for the estimation of nutritional levels necessitates the training of chemical technicians in these procedures. The demand for such trained personnel has exceeded the supply and many of these technicians are now permanent members of the laboratory staff of hospitals, State Health Departments, and the like. Perhaps more important, however, than the training of technical personnel is the incentive which the nutrition survey has provided for the biochemist to develop methods which may be applicable in mass studies and the opportunity to test these methods in practice. Among the more remarkable of these techniques are the several microprocedures which have been described by Lowry, Bessey, and their co-workers (Lowry and Bessey, 1944, '46; Bessey and Lowry, '45; Lowry, Lopez, and Bessey, '45; Lowry and Hunter, '45; Bessey *et al.*, '46). Again, as technical personnel have been trained in these specialized procedures, the demand for them has risen because these techniques are being applied in numerous problems other than those concerned with nutrition surveys.

From the standpoint of allotting nutrition its deserved place in the practice of medical specialties, perhaps one of the most significant contributions of nutrition surveys is that which results from the temporary association of medical personnel with surveys. These physicians often separate from the nutrition study and return to their medical specialty. It is inevitable that the carry-over of nutritional thinking by these persons will be large and that it will influence their own medical practice as well as that of their colleagues. The nature of the field makes such developments of extraordinary importance in the dissemination of sound nutrition practice.

BIBLIOGRAPHY

1. Beebe, G. W.: Medical Evaluation of Nutritional Status. XIII. The Experimental Error of Determinations of Ascorbic Acid in Plasma by Micromethod of Mindlin and Butler. Milbank Mem. Fund Quart., *20:* 389–415, 1942.
2. Bessey, O. A. and Lowry, O. H.: Biochemical Methods in Nutritional Surveys. Am. J. Pub. Health, *35:* 941–946, 1945.
3. Bessey, O. A., Lowry, O. H., and Brock, M. J.: A Method for the Rapid Determination of Alkaline Phosphatase with Five Cubic Millimeters of Serum. J. Biol. Chem., *164:* 321–329, 1946.
4. Borsook, H., Alpert, E., and Keighley, G. L.: Nutritional Status of Aircraft Workers in Southern California. II. Milbank Mem. Fund Quart., *21:* 115–157, 1943.
5. Borsook, H.: Nutritional Status of Aircraft Workers in Southern California. III. Milbank Mem. Fund Quart., *23:* 113–160, 1945.
6. Borsook, H. and co-workers: Nutritional Status of Aircraft Workers in Southern California. IV. Milbank Mem. Fund Quart., *24:* 99–185, 1946.
7. Borsook, H. and Wiehl, D. G.: Nutritional Status of Aircraft Workers in Southern California. V. Milbank Mem. Fund Quart., *24:* 251–299, 1946.
8. Committee on Haemoglobin Surveys, Medical Research Council: Haemoglobin Levels in Great Britain in 1943 (with Observations upon Serum Protein Levels). London. His Majesty's Stationery Office, 1945.
9. Committee on Professional Education of the American Public Health Association: Proposed

Report on the Educational Qualifications of Nutritionists in Health Agencies. Am. J. Pub. Health, *36:* 45–50, 1946.

10. Davidson, L. S. P.: The Teaching of Nutrition to Medical Students. Brit. J. Nutrition, *1:* 102–107, 1947.
11. Downes, J.: Recent Changes in Income and Food Expenditures Among Tuberculosis Families in Harlem. Milbank Mem. Fund Quart., *21:* 158, 1943.
12. Downes, J.: A Study of Food Habits of Tuberculosis Families in a Harlem Area of New York City. Milbank Mem. Fund Quart., *21:* 164, 1943.
13. Downes, J. and Baranovsky, A.: An Experiment in Nutrition Teaching by Public Health Nurses. Milbank Mem. Fund Quart., *23:* 227–253, 1945.
14. Editorial: The Teaching of Nutrition. I, II, III, and IV. J. A. M. A., *133:* 1282; *134:* 23, 146, 292, 1947.
15. Lowry, O. H. and Bessey, O. A.: A Method for the Determination of Five-tenths to Two Millimicrograms of Riboflavin. J. Biol. Chem., *155:* 71–77, 1944.
16. Lowry, O. H., Lopez, J. A., and Bessey, O. A.: The Determination of Ascorbic Acid in Small Amounts of Blood Serum. J. Biol. Chem., *160:* 609–615, 1945.
17. Lowry, O. H. and Hunter, T. H.: The Determination of Serum Protein Concentration with a Gradient Tube. J. Biol. Chem., *159:* 465–474, 1945.
18. Lowry, O. H. and Bessey, O. A.: The Adaptation of the Beckman Spectrophotometer to Measurements on Minute Quantities of Biological Materials. J. Biol. Chem., *163:* 633–639, 1946.
19. Moser, A. M.: Nutritional Condition of Children in Relation to School Lunches in Two South Carolina Rural Communities. Bull. 359, South Carolina Agricultural Experiment Station, Clemson, South Carolina. 1945, p. 54.
20. Muench, H.: Experiments and the Statistician. Nutrition Rev., *3:* 321–322, 1945.
21. ——: Statistics in the Planning and Evaluation of Health Procedures. Am. J. Pub. Health, *37:* 1273–1276, 1947.
22. Section on Professional Education in Nutrition, National Nutrition Conference for Defense. Proceedings National Nutrition Conference for Defense: p. 146. Washington, D. C. May 1941.
23. Smith, H. H.: Nutrition and Public Health. Nutrition Rev., *2:* 257–261, 1944.
24. Stare, F. J.: Medical and Public Health Education in Nutrition. Nutrition Rev., *5:* 1–4, 1947.
25. Technical Committee on Nutrition and Food Management, United Nations Interim Commission on Food and Agriculture: Five Technical Reports on Food and Agriculture, p. 86. Washington, D. C. 1945.
26. The Nutrition Foundation: Proceedings Research Conference on the Relation of Nutrition to Public Health. New York. October 11, 1943.
27. Vanderbilt Cooperative Study of Maternal and Infant Nutrition. To be published.
28. Wiehl, D. G.: Diets of a Group of Aircraft Workers in Southern California. Milbank Mem. Fund Quart., *20:* 329–365, 1942.
29. ——: Accuracy of Hemoglobin Determinations in Fingertip Blood. Milbank Mem. Fund Quart., *24:* 5–28, 1946.
30. —— and Kantorovitz, M.: Medical Evaluation of Nutritional Status. XI. An Analysis of Sources of Errors in Photelometric Macromethod of Determining Ascorbic Acid in Plasma. Milbank Mem. Fund Quart., *20:* 178–206, 1942.
31. Wilder, R. M.: The Teaching of Nutrition in Schools of Medicine. J. Assoc. American Medical Colleges, *18:* 145–157, 1943.
32. Youmans, J. B. and co-workers: Surveys of the Nutrition of Populations, 1, 2, 3, and 4. Am. J. Pub. Health, *32:* 1371; *33:* 58, 955–964; *34:* 368–378, 1943–1944.
33. —— and ——: Surveys of the Nutrition of Populations. Am. J. Hyg., *42:* 254–261, 1945.

Section VII

THE ROLE OF HEALTH DEPARTMENTS IN NUTRITION SURVEYS AND APPRAISAL

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INTRODUCTION

The purpose of this section is to suggest a public health approach to nutrition problems and to point out types of nutritional survey and appraisal work that are most suitable for health departments and related health agencies. Detailed directions for diagnostic procedures are discussed in other sections.

The terms "survey" and "appraisal" are used in a broad sense to include any fact-finding on a public health scale which aids in defining the nutrition problems of population groups or helps to clarify the epidemiology of health conditions related to nutrition.

Obviously, the health department can make limited surveys independently or cooperate with other groups. Its functions and activities will vary accordingly. There are many aspects of nutrition that are primarily the responsibility of other groups, for example, agricultural agencies (1) (2). No one professional group is equipped with the training, experience, or facilities to deal with all phases of nutrition. Whether on an international, national, state, or local basis, the best results come from well-planned cooperative efforts made to answer specific questions. A free interchange of information among the different groups is of advantage.

Nutrition surveys vary widely in character, scope, and degree of complexity. Some are long-range or continuing, whereas others necessarily cover only brief periods of time; some are designed to answer only a few simple questions, while others are quite extensive. Health agencies planning to cooperate in nutrition surveys, or anticipating limited surveys of their own, might consider the following simple questions:

1. Why is the survey being planned?
2. What specific information is wanted?
3. What is the simplest possible way to obtain it?
4. Are personnel, time, and funds adequate for carrying out the plans?
5. What will be done with the information gained?

DEVELOPMENT OF PUBLIC HEALTH NUTRITION APPRAISAL SERVICES

A. Sphere of Activity of Public Health Agencies.—Since different groups are working in this field, many health officials have wondered just what the responsibilities of the health department are (3) (4). This is an important question. In brief, the answer seems to lie in the pattern that has been followed in dealing with other public health problems. If this is true, the health department can contribute most to the *epidemiological* aspects of a national, state, or community nutrition program and can participate in other respects, insofar as practicable (5). The responsibilities might be divided into three phases, as follows:

1. Epidemiological fact-finding designed to locate, analyze, and define nutrition problems.
2. Dissemination of epidemiological information based on the results of investigations.
3. Assistance, directly and through other groups, in corrective and preventive measures.

B. The Epidemiological Approach to Nutrition Problems.—1. The importance of epidemiological information in the field of nutrition: In spite of the mass of nutrition data now accumulated, there is a paucity of information on the epidemiology of many nutrition problems in different areas. Epidemiology applies in the field of nutrition as well as in the field of communicable diseases. It involves the answers to such questions as Who?, What?, Where?, When?, Why?, and How? Some such questions will have to be answered by groups other than public health, and this is one of the reasons for well-planned cooperative studies. It is not enough to know that a given disease is caused by a certain deficiency, but for practical purposes it is necessary to know what habits or conditions bring about the deficiency. Here one may find examples of a merging of the fields of medicine, public health, agronomy, sociology, economics, education, etc.

More health workers, national, state, and local, are beginning to study nutrition as to cause and effect, that is, from the standpoint of etiology of disabilities and the effects of different degrees of nutritional adequacy on physiological efficiency, health level, and longevity. There is need for more study on the possible advantages of better-than-usual nutrition. So-called "optimal nutrition" has not yet been defined clearly, and therefore its potentialities cannot be estimated until much more work is done. Investigative work of this character will point the way toward more satisfactory criteria for nutritional appraisal.

Such problems present a whole new field of opportunity for public health agencies. What other group has the entree, prestige, and medical and scientific background and experience to make comprehensive studies designed to answer questions of this kind?

2. Some Examples of Epidemiological Nutrition Studies: A classical example of an epidemiological approach is the well-known work of Doctor Joseph Goldberger on pellagra (6) (7) (8) (9).

Goldberger studied pellagra in several southern states and used a variety of approaches, all of which tended to give the same answer. He made simple, direct observations, including careful study of both anatomical lesions and functional disorders.

By the application of epidemiological methods, Goldberger found that this disease was not only related to the diet but was due to shortages of unknown nutrients which were present in certain foods and lacking in others. He set up practical though empirical means of combatting the disease. It was several years after Goldberger's death that nicotinic acid, a simple chemical compound, was found to be curative for pellagra (10) (11) (12).

Another illustration of the epidemiological approach to a medical problem on a public health scale is the work of Marine and Kimball (13) and others on simple goiter. Outlined below are some of the more important findings. Simple goiter was found to be:

a. common in certain areas and not in others
b. more prevalent in females than in males
c. more severe in females than in males
d. more prevalent in areas with water supplies low in iodine
e. roughly inversely proportional in prevalence and severity to the iodine content of the water
f. artificially producible in animals by diets low in iodides
g. due to a low intake of iodine
h. prevented by addition of small amounts of iodides to the diet (therapeutic tests)
i. curable in its early stages by iodides (therapeutic tests)

These studies were comprehensive, statistically sound, and left no reasonable doubts as to the cause and prevention of simple goiter.

Following these findings it was not long before several State health departments, including those of Washington (13), Utah (14), and Oregon (15), began surveys to determine the prevalence and severity of this type of goiter in segments of their populations. In Utah, 110,000 individuals were examined for simple goiter during the years 1924–25. One county showed an incidence of 83.5 per cent. The lowest incidence found in any county was 26.3 per cent. Similar surveys were made in several other states including Colorado, Ohio, Minnesota, and Michigan (16).

The relationship of fluorine to dental caries has offered another area for epidemiological investigation of a problem apparently related to nutrition. Over a period of nearly 20 years Dean and his associates have studied the relationship of fluorine intake (content of drinking waters) to dental caries (17) (18). They have approached this problem in various ways.

This group found that children who drink fluorine-containing waters during their

first 8 or 10 years of life have fewer cavities in their permanent teeth than do children who drink fluorine-free waters during this period. About 2 or more ppm. of fluorine in water causes mottling of the permanent teeth, while about 1 ppm. is sufficient to exert a protective influence against caries without producing mottling. These observations have been made on a large scale in many sections of the United States.

A comprehensive study is under way in Grand Rapids, Michigan, of the prophylactic effect on dental caries of *adding* 1 ppm. of fluorine to drinking water. The study is to continue over a period of years. A similar study is being made by the New York State Department of Health in Newburgh, New York. Other investigations are under way in: Brantford, Ontario; Midland, Michigan; and Sheboygan, Wisconsin.

These investigations on pellagra, simple goiter, and dental caries illustrate how public health and other medical groups can study epidemiologically a given condition and seek means for its prevention.

C. Some Problems in the Nutritional Appraisal of Groups.—1. Malnutrition, a group of diseases: The term "malnutrition" as sometimes used appears to designate a single disease. Such usage is misleading since the term does not indicate a single disease entity any more than does the term "infectious disease" (19) (20) (21). It follows, then, that a diagnosis of "malnutrition' is as unspecific as is a diagnosis of "infectious disease." Such diagnoses designate only the general *type* of etiology. One term embraces a group of diseases and disabilities caused by improper intake or assimilation of various food substances; the other term embraces a large group of diseases caused by pathogenic organisms. The signs, symptoms, and pathology of different nutritional diseases may be as diverse as those of various infectious diseases.

Conditions of nutritional origin occur in various combinations and in different degrees of severity, acuteness, and chronicity. Also, they are often complicated by other pathology. Obviously, then, no single test can diagnose malnutrition.

2. Characteristics of Procedures suitable for public health use: Most medical diagnostic methods have been developed for use in private or hospital practice, and many of them are too slow, cumbersome, or expensive for use on a public health scale. This is true of methods used in diagnosing different nutritional conditions (22). Some methods are applicable to group work only in very special circumstances and are not suitable for general field use. Some are too fine for use as screening or diagnostic procedures for groups. Some are subject to wide ranges of interpretation. Apparently such difficulties have discouraged many health officials from attempting nutrition appraisal work.

Public health workers have overcome such obstacles in other fields. For example, in communicable disease work there has been some division of responsibility. This has made it possible for different groups to focus attention on different problems.

In the field of tuberculosis, health workers have developed simple, rapid, and inexpensive diagnostic methods that are suitable for use by health agencies. This is also true of venereal diseases and certain other conditions. Nutrition appraisal techniques for public health use also should be simple, rapid, reasonably accurate, inexpensive, and productive of significant findings.

3. Some problems in correlation of findings: A survey is comparable to a group diagnosis. Health agencies serving different units of population are already accustomed to working with groups of people. No matter how homogeneous a group may appear to be, the findings on individuals comprising it may vary widely.

Before a survey is begun, definite plans for analyzing the results should be formulated (23). A person trained in biological statistical methods should be available to assist in the planning.

When different types of method are used in a single survey, sometimes results appear to be inconsistent. One often encounters the same difficulties in making a diagnosis on a single individual; for example, the data from certain laboratory tests may show little correlation with physical findings, diet records, etc. This is not surprising, since such procedures are not perfect, nearly all are subject to interpretation, and sometimes correlations are expected when they do not exist. Experienced workers in this field have encountered this problem many times.

Closer correlations among different approaches may be apparent when underlying physiology, pathology, and conditioning factors, physical signs and symptoms, laboratory results, diet records, etc., gradually come to be better understood in relation to each other. In the meantime, precautions should be taken in the final interpretation of results.

D. Dissemination of Information and Education of Groups.—1. Motivation of group surveyed: When a nutrition survey is planned, two important educational opportunities should be considered: (a) use of the motivation which can be generated by the survey to improve any unfavorable conditions found, and (b) use of findings for educating the larger group of which the survey group is a sample. These are not by-products, but rather the ultimate purpose of the survey. In making a survey one accepts such responsibility, at least by implication, toward the people studied.

This is true even when surveys are made primarily for scientific purposes. Thus, unexpected antagonisms can often be avoided. Also, more accurate information is likely to result from interested cooperation than from reluctant or incomplete cooperation.

If a long-range study is begun or therapeutic testing is planned, it may be desirable to delay educational efforts until certain "experimental" phases of the study are completed. The reasons are obvious. For example, diet records are taken very casually before anything is said about what the diet *should* contain. Such records, when compiled, should give an approximation of eating habits before any effort is made to change these habits. Of course, records may be taken again following educational efforts directed at improvement.

Educational follow-up should be planned as an integral part of the survey (24). If educational opportunities are not to be utilized locally in connection with a survey, this should be understood in the beginning by the individuals to be studied.

2. Use of results in long-range programs: Group nutrition problems and their ultimate causes should be studied as to both relative importance and probable degree of remediability. When this is done, emphasis can be properly placed in both immediate and long-range educational programs.

Health departments seek first-hand information regarding the prevailing nutrition

problems of the group as a basis for educational activities directed at preventive measures for unfavorable conditions found. These may be taken immediately (short-range), or may be directed at the ultimate solution of the underlying factors (long-range). Usually, a combination of these is desirable.

Soon after Marine and Kimball's (13) work on endemic goiter, many other studies and surveys were made in different sections of the country. The problem was found to be most acute in the Great Lakes region and the Northwest, although widely-distributed smaller endemic areas were found. Of all the areas with a moderate to severe endemic goiter problem, the state of Michigan was the only large area to initiate a sustained, long-range, educational campaign for the application of preventive measures, i.e., the use of iodized salt.

Rarely would the health department adopt direct corrective measures (such as feeding) except in emergencies or for demonstration purposes and then only on a temporary basis (25) (26) (27), for example, yeast furnished to a pellagrous individual. Even this must be accompanied by efforts to improve food habits and conditions underlying poor food habits.

Much wider educational coverage can result when health agencies channel new information through other organized groups, e.g., the schools (28), which come into direct contact with more people for longer periods of time than does the health department.

HEALTH AGENCIES SERVING DIFFERENT UNITS OF POPULATION

A. Int rnational Agencies.—1. World Health Organization: Prominent among the health objectives of the League of Nations (29) was the improvement of conditions related to food and nutrition. Food was recognized as a common denominator among the nations of the world.

More ecently the United Nations, through the World Health Organization (30), is making the second world-wi[illegible]ttempt to deal with health problems on an international scale. World conditions (31) (32) have forced the nutrition problem to the forefront among those destined to influence the course of world events.

2. Food and Agriculture Organization: Aside from emergencies such as war, famine, etc., there is an increasing tendency for food and nutrition authorities to assume a world-wide view of food and nutrition economics. This is in addition to the obvious health implications (33) (34). The Food and Agriculture Organization is an outgrowth of this trend and represents a concerted effort being made by over fifty nations to deal more effectively with food problems which have long been international in character. World War II and its aftermath have emphasized the necessity for voluntary cooperative measures.

It is generally known that national food habits in some countries are detrimental to health (35) (36) and must be improved before certain other public health efforts can become effective. There are indications that public health agencies of different countries will soon be able to furnish more specific information about pressing food needs by providing reliable data based on nutrition appraisals of groups. Admittedly this is a new responsibility for national and international public health organizations.

3. Pan-American Sanitary Bureau: At present 21 nations of the Western hemisphere belong to the Pan-American Sanitary Bureau. A number of these countries in South and Central America (37) are organizing nutrition survey, study, and appraisal units. Representatives from some of these countries are receiving special training in the United States and in Mexico to participate in this program. It is planned that each unit will be directed by a person trained in medicine and nutrition, and will also include one or more nutritionists, a biochemist, and an agronomist. Such units will serve as nuclei for further development if there is continued and increased support by the several countries.

It is feasible for several smaller countries to pool their resources for voluntary cooperative nutrition work under the guidance of international organizations. For example, authorities in Guatemala, Honduras, El Salvador, Nicaragua, Costa Rica, and Panama are planning joint sponsorship of a central nutrition laboratory to be located in Guatemala City. It will serve also as a training and information center for nutrition workers employed by the individual countries. Such cooperative effort would hardly be possible without some form of international sponsorship.

B. National Health Agencies.—The administration and duties of national health agencies interested in nutrition vary from country to country and depend upon a variety of conditions. Some of the objectives and functions of such agencies (38) are discussed below.

A recent poll (39) of 541 public health workers in the United States and Canada indicates an overwhelming opinion that a national health agency should carry out such functions as:

(a) Close cooperation with other national agencies seeking nutrition information.
(b) Collection, analysis, and distribution of nutrition information pertinent to the State and local health departments and the general public.
(c) Consultation to agencies in smaller units of government.
(d) From all available information, furnish facts as a basis for national legislation which will contribute to the improvement of the nutritional status of the public.

Cooperating with smaller units of government (40), national health agencies can assist in and encourage surveys and appraisals on regional bases where problems of a regional nature exist (41). Within recent years agricultural and college groups have cooperated in making such regional studies (42) (43).

There is evidence of increasing interest in nutrition problems by national health agencies in many countries. A few examples are given below:

1. Examples of national public health nutrition services: Canada: Among the better-known national public health nutrition units is the Nutrition Division of the Department of Health and Welfare of Canada. This unit consists of a small staff headed by an individual trained in medicine, nutrition, and public health. This staff serves as a consultation unit for public health workers in the different Provinces of Canada.

Recently the unit made hemoglobin determinations on nearly 1500 school children in 5 areas (44). Nine per cent of these children were found to have hemoglobin levels below 11.9 gm. per 100 cc., which, for purposes of the study, was taken as the dividing line between satisfactory and unsatisfactory hemoglobin levels. Possible

sources of error in making such determinations were discussed and emphasized. The causes of the small percentage of anemia found were not reported.

In 1947 a report was made of a nutrition study of 3200 children in British Columbia and Saskatchewan (45). This study included diet records, laboratory tests, and physical inspections, and was the first such nutrition survey made in Canada. The authors state that, "The surveys are designed to assist local and provincial personnel in ascertaining the type and extent of the nutrition problem, and the means of solving it."

Newfoundland: In 1944 the Commissioner for Public Health and Welfare of the government of Newfoundland organized and sponsored a medical nutrition survey. The study was carried out by some of the leading nutrition authorities of the United States and Canada. A 32-page report, with colored plates and an extensive bibliography, was published in the *Canadian Medical Journal* in 1945 (46). The survey included: an investigation of economic and living conditions, a compilation of data regarding general health, food consumption studies, clinical examinations, biochemical determinations, and an assessment of the available food supply. The study was made on a sample of 868 people in 6 typical areas.

This survey was made in August 1944 and is an example of a short-term intensive study designed to point up specific deficiencies as well as other problems related to nutrition. Reprints of the report have been widely circulated.

This survey was repeated by the same group of physicians in 1948, in order to determine the effect of measures taken to remedy the deficiencies observed in the 1944 survey. Many of those examined in the first survey were re-examined in 1948. The results illustrate how the effectiveness of public health nutrition reforms can be measured and made to provide a factual basis for further development of public health programs and practices.

Egypt: Medical and public health agencies in Egypt have begun nutrition appraisal studies using mobile nutrition survey units (47). These are under the direction of a person trained in medicine, public health, and nutrition.

Philippines: A study to determine the effects of rice enrichment has been undertaken on Bataan through the U. S. Public Health Service and the Department of Health of the Republic of the Philippines.

A nutrition study based chiefly upon microchemical methods was carried out in Bataan, Philippine Islands, during the summer of 1948. Earlier studies had been based chiefly upon physical examinations and diet records. Blood thiamine levels were observed in a population where beri-beri was endemic (70). These initial thiamine levels will serve for making comparisons after a period of feeding enriched rice. The survey was conducted under the auspices of the Williams-Waterman Fund of the Research Corporation in coöperation with the Nutrition Foundation, the U. S. Public Health Service of the Philippines, and Columbia University. The 200 subjects were classified clinically, in relation to beri-beri, as frank, suspected, doubtful, and nonsymptomatic. Significant differences were found in blood thiamine levels of frank and suspected cases compared with doubtful and non-symptomatic cases. The general averages paralleled the symptomology rating. Determination of hemoglobin and serum protein in the field laboratory revealed low hemoglobin levels

in general and a high incidence of severe anemia, with serum protein in a relatively normal range. Analyses of serum for ascorbic acid, vitamin A, and carotene in the laboratories of Columbia University indicated a high incidence of deficiencies in ascorbic acid and carotene. The observed low intake of green and yellow vegetables and fruits afforded an explanation of these two deficiencies.

United States: In 1945 a nutrition section was established in the States Relations Division of the United States Public Health Service (38). Survey teams, which include physicians, nurses, nutritionists, and biochemists, have done nutrition surveys of communities in several areas. This national public health nutrition service will help develop the epidemiological approach to nutrition problems in the United States (48).

2. Some suggestions for expanding national services: Some functions that can probably best be performed by national groups are discussed below.

Most public health workers who have attempted to do nutrition appraisal work have recognized the need for more study directed at standardization of nutrition measurements of all types. So many different criteria are being used that two different groups making surveys in the same area could arrive at quite different conclusions.

The need for evaluation and standardization of laboratory apparatus is urgent. This is particularly true of some of the newer instruments. Such instruments should be appraised under field conditions as to comparative accuracy, reliability, and durability per se and also in relation to cost.

Even some simple items as purchased on the open market may be grossly inaccurate. For example, recently the writers found 20 cu. mm. blood pipettes to deliver as much as 40 per cent too much blood. Numerous such pipettes are found to vary from 5 to 15 per cent from the measurement indicated. It is not always feasible to use exclusively apparatus calibrated by a Bureau of Standards.

A variety of photoelectric colorimeters may give quite divergent results, but some are undoubtedly more dependable than others. Numerous hemoglobinometers on the market today give results which vary considerably. These are but a few examples of equipment of unknown reliability that the public health worker may encounter.

Also, techniques are far from uniform and, therefore, should be critically tested and evaluated. What are the most reliable chemical and hematological methods used in this field? What are the most satisfactory methods of quantitating physical findings? What are the most practical techniques for therapeutic testing in various situations? These are some of the types of questions discussed in Sections I, III, and IV and which deserve further study.

A field to be explored carefully is that of possible relationships between nutrition and various other health problems (49) (50) (51) (52) (53) (54). For example, Trudeau found in 1884 that adequate feeding showed a positive correlation to the healing of tuberculosis (55). Since then, however, little has been done to study and analyze this relationship (56). Knowledge regarding possible relationships of specific nutrients to either susceptibility or treatment of various diseases is still far from complete.

Public health agencies are interested in the relationships of etiologies as well as in the prevalence and severity of specific health problems. This is important in the field of nutrition. National health and related agencies have an opportunity to make epidemiological studies of such relationships.

C. State, Territorial, and Provincial Health Agencies.—A poll of 541 public health workers (39) in the United States and Canada (conducted by the authors) indicates the consensus that State and Provincial Health Departments should set up nutrition units under medical direction to study, appraise, and define nutrition problems within their respective areas (57) (58) (59). The majority feel that the educational programs being carried out by most State departments are good but should be expanded.

Since it is becoming more apparent that nutrition problems are intimately associated with other medical and public health problems, it is increasingly clear that State health agencies must do more to define their own nutrition problems by reorienting their nutrition programs to include more fact-finding, survey, and appraisal (5) (60). One of the first steps would be to collect and study all existing data bearing on the subject within the state.

State agencies naturally assume a position between national and local groups. In nutrition survey work the State group will have some of the characteristics of both the national and the local units.

Few local health departments, except under special circumstances, will be equipped in the near future to carry on extensive nutrition work of an investigative character. The major part of such work will have to be done by State health departments, working in cooperation with local departments. Special personnel will have to be furnished largely by the State.

Undoubtedly nutrition personnel requirements will vary from state to state (61) but facilities should be available for clinical appraisal, biochemistry, hematology, diet studies, and parasitology (in areas where parasitic diseases are prevalent).

Few State health departments have facilities outside of the central laboratories for doing nutrition laboratory work. Mobile laboratories (33) and portable equipment (46) have proved useful in nutrition field-work.

State health departments anticipating nutrition survey programs can begin modestly. Small survey units under medical direction can begin to do nutrition surveys of a limited character (62) (63) (64). These can be directed at single problems (25) (26). Health departments need information on the role that both malnutrition and good nutrition are playing within their areas.

D. Local Health Agencies.—Recently many local health departments have become interested in community nutrition as a public health problem (65) (66). Such departments find it desirable to gather and compile any information which is already available on nutrition in their own communities. The value of such information is increased when it is brought together and studied by interested groups within the community (67). This was amply demonstrated by the work of community nutrition committees during World War II. Some county and city health departments (66) have employed full-time or part-time nutritionists.

Most local health departments are not in a position to carry out extensive nutrition surveys independently. Limited surveys, however, especially in cooperation

with other local groups, are feasible (68). Such studies not only furnish certain facts that are needed but also provide motivating influences toward improving food habits and other conditions which contribute to poor nutrition in the community (69).

If the local health department is planning nutrition survey work it might choose a given problem and, with the simplest procedures possible, study one phase of it at a time. For example, those doing school and pre-school examinations might give extra attention to signs and symptoms which suggest nutritional difficulties; diet records might be kept by representative groups of school children or other organized groups; hemoglobin tests might be done on appropriate population samples and, if unexplained low levels are found, a plan of therapeutic testing with specific substances might be carried out. These are but a few examples of the types of simple beginnings that can be made. Conditioning factors should be considered and adequate control groups should be included.

Probably many local health departments have neglected nutrition appraisal work because of the feeling that they could not do a complete job. Actually, it is frequently preferable to begin modestly and expand gradually.

BIBLIOGRAPHY

1. Maynard, L. A.: Food Production for Better Health and Longer Life. *In* Nutrition and Public Health in the Postwar Period. Detroit, Michigan. Children's Fund of Michigan, 1944.
2. Food and Nutrition Investigations of the Agricultural Experiment Stations. U. S. Dept. of Agriculture, Office of Experiment Stations. Washington, D. C., 1945.
3. Jameson, W.: The Place of Nutrition in a Public Health Program. Am. J. Pub. Health, *37:* 1371–1375, 1947.
4. Sebrell, W. H. and Wilkins, W.: The Role of the Health Department in the National Nutrition Program. U. S. Pub. Health Rep., *58:* 803–813, 1943.
5. Wilkins, W.: New Types of Activity for Nutrition Services in Public Health. Milbank Mem. Fund Quart., *25:* 247–255, 1947.
6. Goldberger, J.: The Etiology of Pellagra. U. S. Pub. Health Rep., *29:* 1683–1686, 1914.
7. Goldberger, J., Waring, C. H., and Willets, D. G.: The Prevention of Pellagra. A Test of Diet Among Institutional Inmates. U. S. Pub. Health Rep., *30:* 3117–3131, 1915.
8. Goldberger, J. and Wheeler, G. A.: Experimental Pellagra in the Human Subject Brought About by a Restricted Diet. U. S. Pub. Health Rep., *30:* 3336–3339, 1915.
9. Parsons, R. P.: Trail to Light, A Biography of Doctor Joseph Goldberger. New York. Bobbs-Merrill Company, 1943.
10. Elvehjem, C. A., Madden, R. J., Strong, F. M., and Wooley, D. W.: Relation of Nicotinic Acid and Nicotinic Acid Amide to Canine Black Tongue. J. Am. Chem. Soc., *59:* 1767–1768, 1937.
11. Fouts, P. J., Helmer, O. M., Lepkovsky, S., and Jukes, T. H.: Treatment of Human Pellagra with Nicotinic Acid. Proc. Soc. Exp. Biol. Med., *37:* 405–407, 1937.
12. Spies, T. D., Cooper, C., and Blankenhorn, M. A.: The Use of Nicotinic Acid in the Treatment of Pellagra. J. A. M. A., *110:* 622–627, 1938.
13. Kimball, O. P.: Endemic Goiter and Public Health. Am. J. Pub. Health, *18:* 587–601, 1928.
14. Goiter Study, Utah State Board of Health. Salt Lake City, Utah, 1925.
15. Olesen, R.: Endemic Goiter in Oregon. U. S. Pub. Health Rep., *42:* 2831–2849, 1927.
16. Olin, R. M.: Iodin Deficiency and Prevalence of Simple Goiter in Michigan. J. A. M. A., *72:* 1328–1332, 1924.
17. Dean, H. T.: Dental Caries and Fluorine. A. A. A. S., Washington, D. C., 1946. p. 5.
18. ——: Post-War Implications of Fluorine and Dental Health. Epidemiological Apects. Am. J. Pub. Health, *34:* 133–143, 1944.

19. Wilkins, W.: Nutrition From the Doctor's Point of View. Virginia Medical Monthly, *71:* 374–379, 1944.
20. Wilkins, W.: Health Problems in Nutrition. Mississippi Doctor, *22:* 279–284, 1945.
21. American Medical Association, Council on Foods and Nutrition: Vitamin Deficiencies: Stigmas, Symptoms and Therapy. J. A. M. A., *131:* 666–667, 1946.
22. Nutrition Survey of Population Groups. Report of a Conference on Methods and Procedures. U. S. Pub. Health Rep., *57:* 189–194, 1942.
23. Muench, H.: Planning Research From the Viewpoint of Later Interpretation of Data. Proceedings, Research Conference on the Relation of Nutrition to Public Health. New York. The Nutrition Foundation, 1943.
24. Wilkins, W., Blakely, R., and Brunson, J.: Hemoglobin Levels of Parker High School Students. J. South Carolina Med. Assoc., *43:* 31–33, 1947.
25. Milam, D. F. and Wilkins, W.: Plasma Vitamin C Levels in a Group of Children Before and After Dietetic Adjustment. Am. J. Trop. Med., *21:* 487–491, 1941.
26. —— and ——: Vitamin C in Normal Nutrition. South. Med. & Surgery, *104:* 191, 1942.
27. Wilkins, W. and Boyd, F.: A Nutrition Demonstration as a Tool for Teacher Training. J. School Health, *12:* 35–42, 1942.
28. Amidon, E. P.: Nutrition Education Through the Schools. J. School Health, *14:* 63, 1944.
29. International Public Health. The Work of the Health Organization of the League of Nations in Wartime. Canad. Pub. Health J., *35:* 39–44, 1944.
30. Parran, T. and Boudreau, F. G.: The World Health Organization: Cornerstone of Peace. Am. J. Pub. Health, *36:* 1267–1272, 1946.
31. Sawyer, W. A.: Achievements of UNRRA as an International Health Organization. Am. J. Pub. Health, *37:* 41–58, 1947.
32. The United Nations International Children's Emergency Fund: Report on Child Nutrition. Lake Success, N. Y. International Children's Emergency Fund, 1947.
33. Second Annual Report of the Director-General to the FAO Conference. Washington, D. C. Food and Agriculture Organization of the United Nations. 1947.
34. Aykroyd, W. R.: Food and Nutrition—Certain International Aspects and Developments. J. Am. Dietetic Assoc., *24:* 1–4, 1948.
35. Robinson, W. D., Janney, J. H., and Grande Covian, F.: An Evaluation of the Nutritional Status of a Population Group in Madrid, Spain, During the Summer of 1941. J. Nutrition, *24:* 557–584, 1942.
36. Stuart, H. C.: Appraisal of the Nutritional State of Children in Programs of Relief Feeding. Nutrition Rev., *2:* 225–227, 1944.
37. Murdock, J. R.: Personal Communication.
38. Wilkins, W. and Sebrell, W. H.: Developments in Public Health Nutrition Appraisal. Fed. Proc., *4:* 258–263, 1945.
39. Personal Communications.
40. Adler, S. W. and Wilkins, W.: A Digest of Nutrition Conferences. New Mexico Health Officer, *12:* 1944.
41. Sebrell, W. H.: The Nature of Nutritional Diseases Occurring in the South. Milbank Mem. Fund. Quart., *17:* 358–366, 1939.
42. Fincke, M. L.: The Ascorbic Acid (Vitamin C) Metabolism of College Students. A Cooperative Study. J. Am. Dietetic Assoc., *16:* 325–328, 1940.
43. Donelson, E., Nelson, P. M., Ohlson, M. A., Pittman, M. S., Leverton, R. M., McKay, H., Kinsman, G. M., Armstrong, W., and Reynolds, M. S.: Nutritional Status of Midwestern College Women. J. Am. Dietetic Assoc., *21:* 145–147, 1945.
44. Pett, L. B., Hanley, F. W., and Perkins, E.: Haemoglobin Levels of Children in British Columbia. The Bulletin, Vancouver Med. Assoc., *22:* 128–132, 1946.
45. Pett, L. B. and Hanley, F. W.: A Nutrition Survey Among School Children in British Columbia and Saskatchewan. Canad. Med. Assoc. J., *56:* 187–192, 1947.
46. Adamson, J. D., Jolliffe, N., Kruse, H. D., Lowry, O. H., Moore, P. E., Platt, B. S.,

Sebrell, W. H., Tice, J. W., Tisdall, F. F., Wilder, R. M., and Zamecnik, P. C.: Medical Survey of Nutrition in Newfoundland. Canad. Med. Assoc. J., *52:* 227–250, 1945.

47. Abbasy, M. W.: Personal Communication.
48. Anderson, R. K. and Sandstead, H. R.: Nutritional Appraisal and Demonstration Program of the U. S. Public Health Service. J. Am. Dietetic Assoc., *23:* 101–107, 1947.
49. Burke, B. S.: Nutrition—Its Place in Our Prenatal Care Programs. Milbank Mem. Fund Quart., *23:* 54–65, 1945.
50. Tompkins, W. T.: Improved Nutrition Services for Pregnancy and Infancy. A New Approach to Nutrition Services in State Health Departments. New York. Milbank Memorial Fund, 1947.
51. Ebbs, J. H., Tisdall, F. F., and Scott, W. A.: The Influence of Prenatal Diet on the Mother and Child. J. Nutrition, *22:* 515–526, 1941.
52. King, C. G. and Menten, M. L.: The Influence of Vitamin C Level Upon the Resistance to Diphtheria Toxin. J. Nutrition, *10:* 129–140, 1935.
53. Cannon, P. R.: Importance of Proteins in Resistance to Infection. Nutrition and Public Health in the Postwar Period. Detroit, Michigan. The Children's Fund of Michigan, 1944.
54. Editorial: Nutrition in Relation to Cancer. J. A. M. A., *135:* 644, 1947.
55. Trudeau, E. L.: An Autobiography. New York. Doubleday, Page Co., 1916.
56. Edwards, H. R.: Opportunities for Application of Nutrition in the Prevention and Treatment of Tuberculosis. A New Approach to Nutrition Services in State Health Departments. New York. Milbank Memorial Fund, 1947.
57. Getting, V. A.: A Modern Nutrition Program in a State Health Department. Milbank Mem. Fund Quart., *25:* 256–262, 1947.
58. Amyot, G. F.: National, Provincial, and Local Nutrition Programs in Canada. U. S. Pub. Health Rep., *58:* 793–796, 1943.
59. Wilkins, W.: Can Health Departments Get the Facts? J. School Health, *14:* 56–59, 1944.
60. Nutrition for Young and Old. New York State Joint Legislative Committee on Nutrition, Legislative Document No. 76, 1946.
61. Blakely, R.: Nutrition Investigations and Services. Florida State Health Notes, Florida State Board of Health, *39:* 157–160, 1947.
62. Wilkins, W. and Blakely, R.: Rapid Hemoglobin Determinations on School Children. J. School Health, *16:* 196–199, 1946.
63. —— and ——: Preliminary Observations on Diurnal and Other Variations in Hemoglobin Levels. Milbank Mem. Fund Quart., *24:* 359–372, 1946.
64. Pierce, H. D., Fenton, P. F., Wilkins, W., Newland, M. E., and Budge, P. S.: Nutritional Defects Among Children in Vermont. New England J. Med., *233:* 612–617, 1945.
65. Willard, W. R.: Working for Better Nutrition in a Rural Community. Am. J. Pub. Health, *32:* 996–1000, 1942.
66. McPheeters, S. B.: The Fuller Utilization of Nutritional Knowledge by Local Health Departments. A New Approach to Nutrition Services in State Health Departments. New York. Milbank Memorial Fund, 1947.
67. Turner, M.: Nutrition and the Community. J. Am. Dietetic Assoc., *21:* 22–23, 1945.
68. Souther, S. P.: Shall Public Health Physicians Attempt to Assess Nutritional Status of School Children? Am. J. Pub. Health, *32:* 166–170, 1942.
69. Hilbert, H.: The Role of the Nurse in Improving the Nutritional Status of the Community. A New Approach to Nutrition Services in State Health Departments. New York. Milbank Memorial Fund, 1947.
70. Salcedo, J., Jr. et al.: Studies on Beriberi in an Endemic Subtropical Area. J. Nutrition, *36:* 561–577, 1948.

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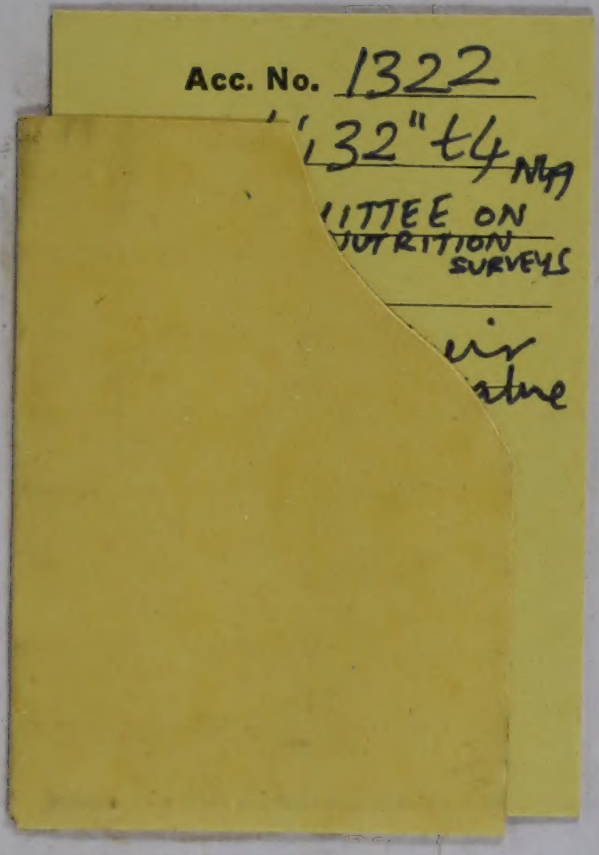
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